FINAL REPORT

SUMMER COURSE - FUNDAMENTAL

CONCEPTS OF ENVIRONMENTAL AND PLANETARY SCIENCES

NSR-10-007-032

Sponsored By

The National Aeronautics and Space Administration

The U.S. Department of State

and The University of Miami

June 17 to July 22, 1966

School of Environmental and Planetary Sciences

University of Miami

Coral Gables, Florida

FINAL REPORT

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SUMMARY

The Second Summer School on the Fundamental Concepts in Environmental and Planetary Sciences was organized as part of the regular Summer Session of the University of Miami under co-sponsorship of the National Aeronautics and Space Administration (NASA), the U.S. Department of State, the Comite Interamericano de Investigaciones Especiales, and the Gulf Universities Research Corporation. The NASA provided the major part of the financial support for this program while the other listed organizations with the exception of GURC provided partial financial support. The participants in the program included 28 U.S. and 12 foreign students from 10 countries, and 40 lecturers including 1 from Great Britain.

The principal activity of the Summer School was a series of 108 lectures in which physics, astrophysics and astronomy, conventional and satellite meteorology, conventional and space oceanography, and solid earth sciences were synthesized into a description of what may be called a fundamental course in the Environmental Sciences. Dr. Kuldip Chopra gave a number of lectures in general areas to build basic background and to provide a continuity and inter-relationship between several specialized lectures given by him and the participating faculty. The lecturers were drawn from the various disciplines and from throughout the United States.

Field trips and tours to other facilities were arranged each Friday afternoon, with a two day trip to the Cape Kennedy Space Flight Center at the end of the course in which the participants gained acquaintance with some of the technical and experimental realities of the current national

effort in environmental sciences.

It appears that the Summer School was a very successful experiment from the points of view of broadening students' outlook, stimulating their interest and curiosity in the ever-expanding challenges in environmental sciences and towards the build-up of a program which may eventually form the basis for an undergraduate curriculum in environmental sciences. We have received letters from several organizations urging the organization of another school next year and indicating their desire to send participants.

2. OBJECTIVES AND GOALS OF THE PROGRAM

The primary objectives of the "Second Summer School on the Fundamental Concepts in Environmental and Planetary Sciences" were:

1. To introduce a select group of bright undergraduate students in physical sciences with a view towards extending their basic science courses into disciplines which are not normally covered in a standard undergraduate curriculum;

2. To acquaint this group of undergraduates with the challenges and the opportunities offered by advanced (graduate) studies and careers in the environmental and planetary sciences.

The secondary goals of the program were:

1. To study the feasibility, by actual experimentation with this select group of students, of an undergraduate program in environmental sciences based on the above-average junior-level college background in physical sciences;

2. To provide opportunities for some foreign students to benefit from the program, the parallel of which is non-existent in their own countries; and

3. To encourage the under-graduate students in science from the U.S. to interact with their counter-part students from abroad.

3. ORGANIZATION OF THE PROGRAM

The educational program of the University of Miami's Second Summer School on Environmental and Planetary Sciences was organized to provide a balance of lectures between the following four disciplines:

1. Astrophysics, Astronomy and Space Physics

2. Solid Earth Sciences and Meteoric Physics

3. Atmospheric Science including conventional and satellite (Space) Meteorology, and

4. Conventional and Satellite (Space) Oceanography

Approximately 1/5 of the total number of lectures were devoted to the review of some fundamental concepts in physical sciences needed for the comprehension of the above listed disciplines and to provide a continuity in the program.

To supplement the above educational program, tours were arranged to the NASA's Space Flight Center at Cape Kennedy; the University of Miami's Institute of Marine Science, Radar Meteorology Laboratory, and the Computer Center; and the ESSA's National Hurricane Research Laboratory and the Tropical Meteorological Center, both located at the University of Miami campus; and ESSA's Research Flight Facility located at the Miami International Airport.

To foster direct interaction, educational and social, between the U.S. students and their foreign counterparts, the University of Miami organized several social events like welcome tea, group luncheon, a picnic, etc.

4. RECRUITMENT OF STUDENTS

Applications from students desirous of participating in this year's program were invited through brochures (Appendix 1) sent out to the various college and university campuses. Some of them learned about the program from their friends who had attended the First Summer School conducted in the preceeding year. Many applicants became aware of the program through their local and campus news media and the publication of announcements in the general science journals: the "Science" and the "Physics Today". The participants from abroad learned about this program from their friends, and through the cooperative efforts of the Bureau of Cultural Affairs of the U.S. Department of State and the Comite Interamericano de Investigaciones Especiales. The GURC (Gulf Universities Research Corporation) had voted to co-sponsor this year's program and it urged its affiliate institutes and universities to participate in the program.

The applications received at the University of Miami were screened by an academic committee set up by its Institute of Atmospheric and Space Science. The U.S. Department of State picked its representatives (participating students) through its missions abroad. All applications from the Latin-American students received at the University of Miami were referred to the Comite Interamericano de Investigaciones Especiales. The inter-american committee was also advised of the criteria for selection of participants adopted by the University of Miami's academic committee, but, the actual selection of the Latin-American participants was left entirely at the discretion of the Inter-American Committee.

The academic committee at the University of Miami adopted the following criteria for the selection of student participants:

1. ACCEPTABLE I: Grade "A" all the way through.
2. ACCEPTABLE II: Above-average "B" grade with "A" grade in Physics and Mathematics.
3. ACCEPTABLE-ALTERNATE: Above-average "B" grade with "A" grade in either Physics or Mathematics
4. All others

Those meeting the first two requirements were accepted out-right; those satisfying the third requirement were put on a waiting list, and all others were denied acceptance and award of scholarship. Among the non-acceptables were two graduate students and one who had attended the First Summer School held in the preceeding year. Six in the ACCEPTABLE-ALTERNATE category were finally accepted.

In this manner, a group of 40 participants (including those sponsored by the U.S. Department of State and the Inter-American Committee on Space Investigation) was formed.

The form letters to the Acceptable, Acceptable-Alternate and Non-Acceptable applicants are also reproduced in the Appendix 1.

5. STATISTICS ON STUDENT PARTICIPANTS

The names of the student participants are listed in alphabetical order in Appendix 2. Against each name are given the name of the institute (college/university) where the student is currently enrolled and his/her home address.

Among a total group of 40 student-participants, there are two lady students: one white and the other colored. The remaining 38 student participants are classified as 31 white, 2 colored, 2 Arabs and 3 Chinese.

The regional distribution of the U.S. student participants was as follows:

Northeastern States	39.3%
Southeastern States	25.0%
Central States	28.6%
Western States	7.1%

Thirty percent (30%) of the students were from abroad as compared to Twenty-One percent (21%) in the preceeding year. Of these, five students were already enrolled in colleges and universities in the U.S.A.

Similarly ten (10) countries (including the United States) were represented in the class as compared to six (6) countries in the preceeding year's group.

Foreign representation would have improved had it been possible for a student from Norway and for another from Peru to participate. These students could not come for reasons of lack of funds for travel between Norway and U.S.A. and for lack of time for making arrangements for travel from Peru to the United States, respectively.

The geographical distribution of the student participants was as follows:

United States of America	28
Argentina	2
Belgium	1
Bolivia	1
Brazil	1
Hong Kong	2
Iran	1
Jamaica	2
Panama	1
West Germany	1
Total	40

The group included three married students. These three married students and another local student lived off-campus with their families; all others were put up in the university dormitories.

The academic background data is available on only 37 student participants. Based on the major subject of study of each student, one would arrive at the following data:

Physics	27
Mathematics	1
Astrophysics	1
Astronomy	1
Atmospheric Science	3
Chemical Engineering	1
Electrical Engineering	2
Mechanical Engineering	1
Not applicable	3 *
Total	40

6. RECRUITMENT OF FACULTY

An extensive list of topics in the various disciplines listed in Section 3 was prepared for inclusion in the academic curriculum of the program. A second list of prospective participating faculty was then prepared by picking a small number of experts in each topic. The reputation of an expert as a scientist and as a teacher formed the basic criteria for inclusion of a person in this list.

* Professionals selected directly by the Department of State.

The educationists on the second master list were then contacted on the phone to explain to them the objectives of the program and to ascertain their availability. A resort to telephone contacts was made necessary because the writer of this report under-took the responsibility to organize and direct the program in less than four weeks before the commencement of the program.

The response from the prospective faculty participants was exceptionally good and very gratifying, so much so that the initial plan of restricting three lectures on each day was abandoned, and, instead, five lectures were scheduled on four days a week, and 3 lectures on each Friday, leaving the Friday afternoon free for field trips to other facilities.

An effort was made to keep a balance between the faculty participants from GURC and non-GURC institutes. Of course, a large proportion of the faculty was drawn from the University of Miami (a GURC affiliate) to keep the cost of operations from sky-rocketing.

Those who agreed in the telephone conversation to participate in the program were contacted once again in a follow-up letter. The form letter extending the invitation to participate and a courtesy form letter expressing appreciation for the faculty member's participation are reproduced in Appendix 3.

7. STATISTICS ON FACULTY PARTICIPANTS

A total number of 40 scientist-educators participated in the instruction of the Second Summer School on the Fundamental Concepts in Environmental and Planetary Sciences. The number of faculty participants in each discipline is given below:

Discipline	No. of Faculty Participants
General Lectures (Opening and Closing Sessions)	5
Astrophysics, Astronomy and Space Physics	12
Solid Earth Sciences and Meteoric Physics	3
Atmospheric Science including Conventional and Satellite (Space) Meteorology	14
Conventional and Satellite (Space) Oceanography	16

Many faculty participants lectured on topics falling in more than one discipline.

Based on their professional background and training, these lecturers could be classified as follows:

Astronomy	2
Astrophysics	1
Atmospheric Science	7
Oceanography/Marine Science	6
Geochemistry/Oceanography	4
Physics/Geophysics	1
Geophysics (Earth Science)	1
Physics/Oceanography	5
Physics/Atmospheric Science	4
Physics/Space Science	3
Physics/Astrophysics	5
Education	1

8. ACADEMIC PROGRAM

The 40 lecturers in Environmental Sciences gave a total of 108 lectures of 1 hour duration each as detailed below:

Discipline	No. of Lecturers	No. of Lectures
General (Opening and Closing session)	5	5
Astrophysics, Astronomy and Space Physics	12	19
Earth Sciences & Meteoric Physics	3	18
Atmospheric Physics including conventional & satellite meteorology.	14	37
Conventional and Space Oceanography	16	29
Total	40	108

The schedule of lectures is given in the Appendix 5. Most of the lectures were devoted to the major topics listed above and in the schedule of lectures. A few extra lectures were usually squeezed in the program in wich the Associate Director introduced basic concepts to provide the background material needed for the specialized lecture or to provide continuity or inter-relationship of the various lectures. For example, fundamentals of plasma physics and magnetohydrodynamics were discussed on the afternoon of July 1 following the tour to the Research Flight Facility.

We were indeed very fortunate to be able to gather a group of exciting lecturers who are at the fore fronts of their specialties. The course provided an excellent opportunity for the students to come into contact with active researchers, whose methods of approach were as varied as their specialties. These contacts helped the students form some ideas about what a geophysicist or space scientist does, and how he performs his research, and what he finds exciting. The student body was somewhat shy in the beginning, and the Associate Director had really to prod them into discussion with the lecturers. But the initial ice was defrosted soon, and the writer of this report had to do the unfortunate job of cutting off heated discussion so the other lecturers could follow. These discussions emphasized the fact that controversy still exists and that much work remains to be done, perhaps by the students themselves in the years to come.

The success of this course as evidenced by the lively interaction between the lecturers and students in spite of long assembly hours (9:00 a.m. to 4:30 p.m. each day) was due also to the fact that in spite of their general mastery of subject and excellence in lecturing, the faculty participants had taken great pains in preparing course outlines of their respective lectures and lists of recommended reading material. This additional material is compiled in Appendix 6. An effort was made to assemble this material for ready availability to students. It must however, be admitted that much remained to be done in this regard because of the lack of organizational time.

At the end of the course, students were given a closed book examination. The questions are reproduced in Appendix 7. The students obtained the following grades:

Grade	No. of Students
A	8
B	30
C	2

All the student participants received diplomas certifying their successful participation in the course. A copy of the certificate is reproduced in Appendix 8. The University of Miami would give 6 credits at the 500 level to each successful participant.

9. FIELD TRIPS AND TOURS

A number of field trips and outside activities were arranged for the participants in the course, ranging in magnitude and scientific or social merit from a two-day visit to the Cape Kennedy Space Flight Center to a 1-hour long reception where tea and coffee were served.

The opening day, Friday, June 17, 1966 was the hub of a variety of such activity. In the afternoon, Professor Chopra escorted the participants to visit the Computer Center and the Radar Meteorology Laboratory. Professor Homer Hiser, Director of the Radar Meteorology Laboratory personally conducted the tour of his facilities, and, here the students gained a first hand experience on the use and interpretation of the radar equipment in meteorological observations from a scientist noted for his professional experience and teaching.

The same afternoon, students were invited to a reception in the Meditation Garden of the Ferre Building, where students had an opportunity to meet and get to know each other and faculty members from various departments at the University of Miami.

The following Friday, June 24, students visited the U.M.'s Institute of Marine Science located at Virginia Key. That morning the lectures on behavioral and sensory biology of marine matter illustrated by sound-motion pictures, were given by Professor Myerberg at the Institute. A group luncheon was arranged at The English Pub restaurant, and this was followed by a tour of the Institute.

In the evening of July 24, students and faculty were invited to a picnic at Tahiti Beach where dinner was served and the participants availed themselves of the facilities for swimming and dancing. By now the initial strangeness disappeared, and the faculty and student participants developed a feeling of belonging to one closely knit unit. A psychological basis for close interaction between students and faculty and between students had set in.

On the afternoon of July 1, the group was transported to the Research Flight Facility. Here, the participants inspected the RFF, Navy and Air Force instrumented reconnaissance aircraft that participated in the Hurricane Hunter program. After the inspection tour, the group was met by the representatives of the Research Flight Facility for a brief presentation on the scientific problems concerning the reconnaisance plane operation.

On July 8, 1966, the students visited the facilities of the ESSA's National Hurricane Research Laboratory and the Tropical Meteorological Center, both located in the Computer Center building on the main campus.

The following Friday and Saturday groups of students were taken to the astronomical observatory of the University of Miami located in West Palm Beach.

The last event of the Summer School program was the 2-day trip to Cape Kennedy. On the morning of Thursday, July 21, Professors Chopra and Runcorn escorted the group in two chartered buses to Cape Kennedy. The itinerary of the trip is given in Appendix 9. The group stayed overnight at the Ramada Inn Motel in Cocoa Beach and returned to Miami about 6:00 p.m. Firday evening.

10. STUDENT EVALUATION OF THE PROGRAM

No completely objective estimate of the students' response to the course is possible, but an attempt was made to obtain this evaluation by a series of informal interviews and by soliciting their response to the course on a questionnaire form circulated during the last week of the course. A copy of this questionnaire forms the Appendix 10 of this report. The resultant data from the questionnaire is suggestive rather than definitive, partly because of the inherent difficulties in such a measurement and partly because not all the students commented on all the questions.

The answers to the questionnaires returned were analyzed on the basis of a three-point scale, ranging from excellent through fair to poor. The assignment of these numerical values is somewhat arbitrary, but, it was felt that the exposition type questionnaire would be much more helpful in determining the real feeling of the student than a long list of questions for the student to assign a point value to. The latter would have tended to discourage comments on aspects of the program overlooked by the questionnaire and would have given no indication as to the degree to which the student felt the question pertinent. The questionnaire and its form encouraged the student to comment on the points he felt germane and to abstain from comment on those he felt trivial or about which he had no particular feeling.

Eighty percent of the students rated the course content as Excellent, another ten percent rated it as Fair and the remaining ten percent summarily commented "Found lectures Boring". The analysis of their recommendations for modifying it indicated that there was no consensus as to what direction it should follow. Two students complained of less emphasis having been placed on experimental work whereas four students complained that there should have been more emphasis on theoretical approach. Likewise, one student recommends more emphasis on plasma physics, four students would like to see astronomy and astrophysics emphasized more. They enjoyed meteorology most (Professor Hess wins the jack pot in priase) but they felt that meteorology in general was over-emphasized. Apart from these comments, the students felt that the course was over-all well balanced in content and approach.

There were more numerous suggestions for the improvement of presentation. Whereas, the students enjoyed most of the lectures, students found some slides and graphs in a few lectures a bit too excessive. They feel that restricting instruction in a particular discipline, say meteorology or astronomy, to just one week would have provided better continuity. Others desire the distribution of lecture outlines in advance and the reference literature more readily available. Two students suggested that fewer lecturers, each covering a broader subject would be more beneficial, and seven students favored a variety of lecturers. One student felt that a few lecturers over-shot the allocated time and that there should have been some mechanism, like bell or alarm clock, to put a time restraint on the lecturer. Apart from the above comments, students praised the enthusiasm, organization of material and presentation of the lecturers. Professors Chopra, Duke, Hess, Hitschfeld, Isaacs, Lidell, Ostlund, Page, Roach, Runcorn and Singer (arranged in alphabetical order) came in for special mention; Dr. Hess winning the popularity vote.

Forty percent of the students were dissatisfied with the trips; only 60 percent rated the trips Fair or Excellent. However, no definite conclusion can be drawn from their comments. For example, one student comments that all the trips were excellent, and he would like to see more trips arranged. Another student felt that the only useful trip was to the I.M.S. One student found the visit to the observatory extremely interesting and took every opportunity to visit the facility (beyond the organized tours). One participant found the visit to Cape Kennedy very informative and challenging while two others felt it was a waste of time. Most favorable votes went to the Institute of Marine Science, and the least favorable comments were on the visits to the ESSA and the Computer Center Facilities on the U.M. Campus.

Except for three students who felt that the course was successful in stimulating them and broadening their outlook on science, most were confounded with the opportunities and challenges offered by the environmental sciences, and indicated that at the end of the course they could not decide which discipline to take, that they were over-fed with the food of knowledge and now needed time to digest. The author of this report felt gratified as he had set this as the criterion of success of the course, his objective having been to stimulate curiosity in young minds.

11. FINANCIAL SUPPORT

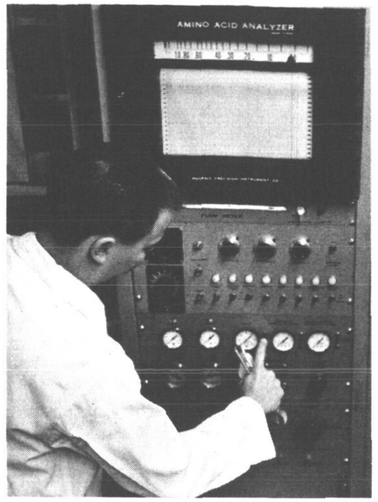
The basic support for the course to cover the honoraria and local (within the United States) travel of lecturers, the local travel and subsistence stipends for 36 students and some administrative costs came from the National Aeronautics and Space Administration. The Bureau of Cultural Affairs of the U.S. Department of State supported the local and international travel, tuition and subsistence of four students from Latin America. The Comite Interamericano de Investigaciones Especiales provided for the international travel of three students from South America. The ESSA's National Hurricane Research Laboratory provided a lecturer at no cost.

12. CONCLUSIONS

The Second Summer School on the Fundamental Concepts in Environmental and Planetary Sciences was a very successful experiment. All the objectives listed in the first section were accomplished to a major degree. The students were exposed to the vista of challenges and opportunities offered by the environmental sciences. Their outlook, knowledge and background was considerably broadened through lectures and personal contact with the lecturers, most of whom are at the fore-fronts of science in their respective fields. In other words, these young bright minds emerged from this course as sophisticated young scientists. The well mixed international nature of the student body contributed to good international understanding. Last but not the least, this Summer School experiment produced a convincing evidence that a sound undergraduate curriculum in environmental sciences can be established, at least for the benefit of some brilliant students and to augment the supply of trained personnel in the newly emerging Environmental Sciences. But, this experiment will have to be repeated for a few years with modifications introduced each year based on the previous years experience before this dream can be realized.

APPENDIX 1

RECRUITMENT OF STUDENTS



Synthesis of amino acids forms an important area of research in the Institute of Molecular Evolution.

Summer living in the Miami area is pleasant. The average maximum temperature along the coast is 88°; the maximum temperature has never exceeded 95°. Inland, at the airport and west of the airport, the temperatures are about 5° higher. The Gulf Stream and sea breezes keep the temperature from rising to the high values which are experienced in the northeast United States and the midwest. Ocean swimming, boating, fishing are available the year 'round and are particularly good during the summer. Living expenses are very low, since this is the off-season for tourists.

Classes will be conducted in a completely air conditioned modern building. Most housing is also air conditioned.

Various social events will be arranged, including picnics, boat excursions, etc. Living is very informal: light clothing and rainwear are recommended.

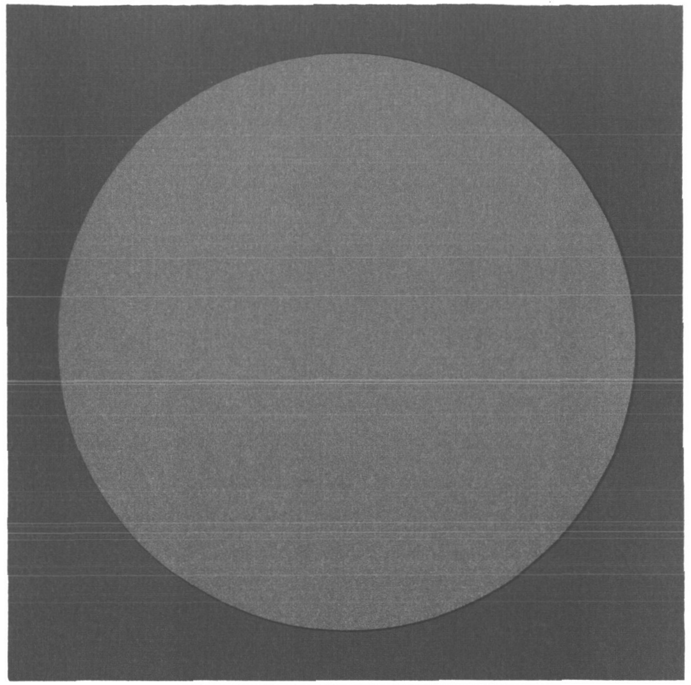
Cultural facilities are available during the summer, including The Southern Shakespeare Repertory Theatre on the University of Miami campus, concerts, and films.

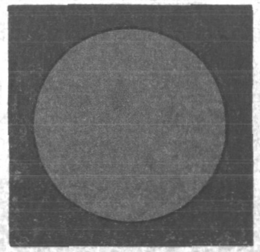
The Institute of Marine Science operates oceanographic research vessels, an acoustic range facility for underwater sound investigations, mass spectrometers and low-level counting equipment for geochemical and radiochemical investigations, with particular reference to cores of the ocean bottom. The Institute of Atmospheric Science has access to a weather satellite readout station, instrumented aircraft in the Weather Bureau's Research Flight Facility, and meteorological sounding rockets.

The Institute of Space Physics operates a small but well equipped astronomical observatory suitable for planetary observations.

The Institute of Molecular Evaluation conducts a variety of research programs relating to the transformation of molecules into living matter.

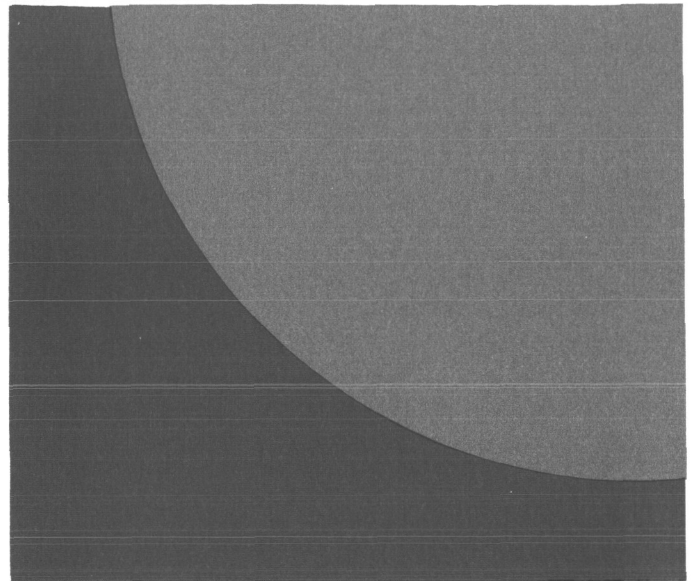
Graduate Fellowships and Research Opportunities in the environmental and planetary sciences exist at the University of Miami and will be available to students enrolled in this program. Applications should be addressed to the Director of the Institute in which the student wishes to conduct research graduate work.

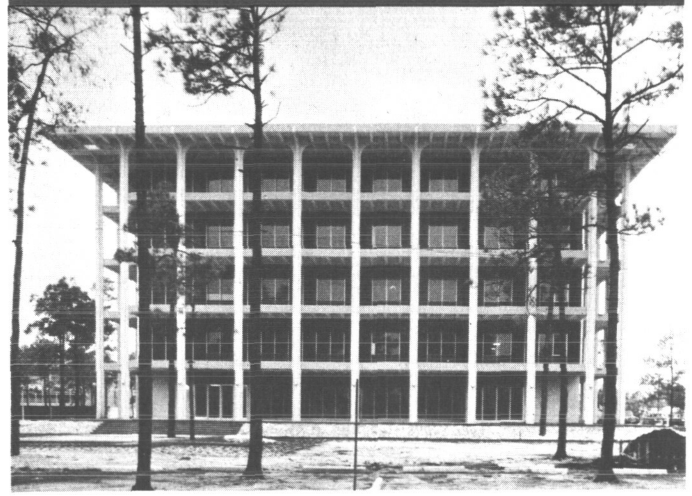




School of Environmental and Planetary Sciences

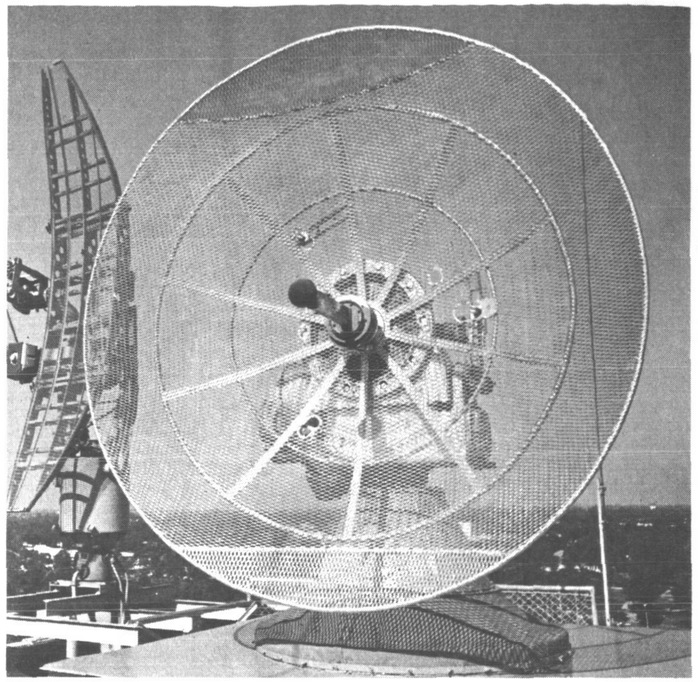
University of Miami
Coral Gables, Florida 33124





School of Environmental and Planetary Sciences
Summer School Session

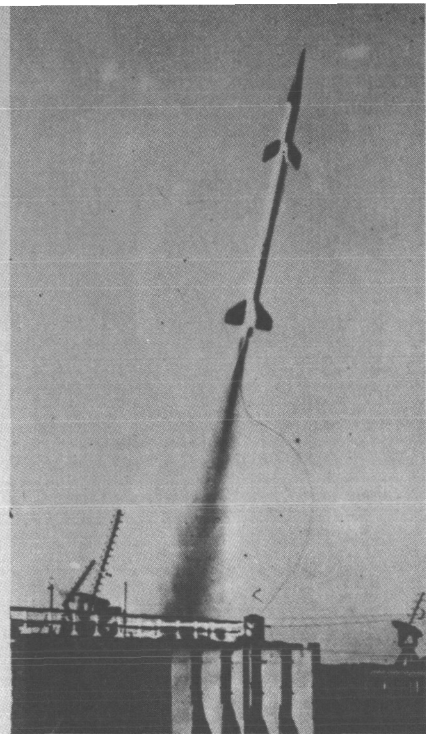
University of Miami / Coral Gables, Florida 33124



FUNDAMENTAL CONCEPTS IN ENVIRONMENTAL AND PLANETARY SCIENCES

University of Miami / Coral Gables, Florida
Sponsored by the
National Aeronautics and Space Administration
North Atlantic Treaty Organization
June 17 to July 22, 1966

Above:
Merrick Building antennas are a part of the Radar Meteorology Laboratory. In addition to research in atmospheric science, this facility forms a back-up service to the U.S. Weather Bureau radar system, also located on the University of Miami campus.



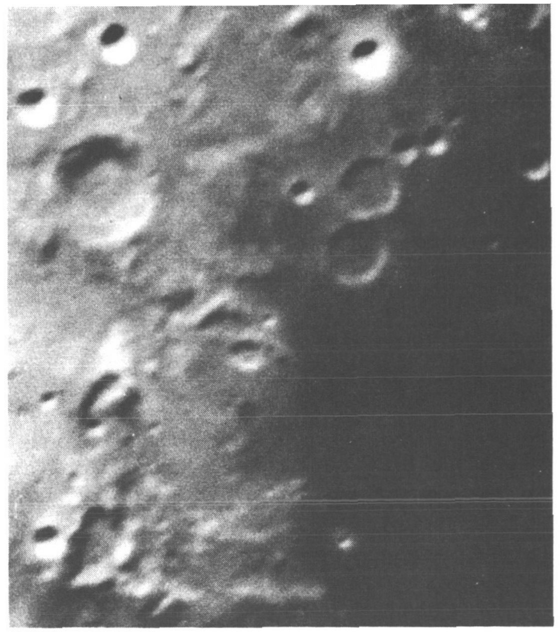
Undergraduate Grants

The University of Miami announces a program of undergraduate grants for participants in the Summer Course: Fundamental Concepts in Environmental and Planetary Sciences. The summer course will be a part of the regular summer session of the University of Miami and will be directed by Dr. S. Fred Singer, Dean of the School of Environmental and Planetary Sciences. Grants providing for all expenses of the participants will be awarded to U.S. and foreign undergraduates majoring in the physical sciences. Lectures will be presented by 24 internationally known scientists from the Americas and Europe.

Summer Course Program

The course is designed to develop and expand fundamental physical concepts underlying the various subject areas represented by the Institutes of the School of Environmental and Planetary Sciences: Marine Science, Atmospheric Science, Space Physics, Planetary Studies, and Molecular Evolution.

Major emphasis will be placed upon fluid dynamics in the context of geophysics and planetary physics: flow phenomena, including geostrophic flow; boundary layers; wave propagation; transfer of mass and energy by convection and turbulence; energy transfer by radiation. Applications will be given to a wide variety of phenomena, including gravity waves and acoustic waves in the oceans and radiation transfer in the earth's atmosphere. The scientific basis of weather satellites will occupy a considerable portion of the course.



A photograph of the impact area on the surface of the moon at the moment of impact of Ranger VIII, taken from the West Palm Beach Observatory of the Institute of Space Physics as part of the program to discover more about the nature of the lunar surface.

Topics will be presented from statistical mechanics and extending to plasma physics. Applications of the theory will include the earth's exosphere, radiation belts, interplanetary dust distribution, and the interaction of a body moving through an ionized gas.

A group of special lectures will be presented to outline the current research in a number of areas related to the work of the School: molecular evolution; physics of the solid earth; marine geology; aeronomy; and interplanetary physics.

Academic Credit

The program carries academic credit of six units in the summer session of the University of Miami.

Field Trip

The final phase of the program will be conducted at the John F. Kennedy Space Center and will include a tour of the Space Center.

Facilities

University of Miami residence halls will be available for housing the participants during their stay on the University of Miami campus. Health services, cafeteria services, and library facilities will be available to all students.

Eligibility

To be eligible for participation, each applicant must have a background equivalent to three years of college training in mathematics and the physical sciences. Mathematics through advanced calculus is essential. Advanced undergraduate courses in theoretical mechanics, electricity, and modern physics are desirable, including some familiarity with vector analysis and differential equations.

Applications will be considered when received. The deadline for the receipt of Scholarship Applications for the Summer Course is May 1, 1966.

Scholarships

Scholarships are available to qualified students; they provide for all tuition and fees, $60 per week subsistence, and travel expenses round trip to Miami, as well as all travel expenses associated with the program.

These scholarships are provided for by grants from the National Aeronautics and Space Administration and the North Atlantic Treaty Organization. Five of the scholarships available for students outside the United States are offered jointly by NASA and its regional space organization, under which all expenses of foreign travel are provided by the regional organization.

Additional scholarships for students from Central and South America will be provided by direct grants from the U.S. Department of State. All inquiries should be directed to the address below.

Procedure for Application

Applications for grants will be reviewed by a faculty committee of the School of Environmental and Planetary Sciences. The application should be submitted in the form of a letter to: Dr. S. Fred Singer, Dean, School of Environmental and Planetary Sciences, University of Miami, Coral Gables, Florida 33124, U.S.A.

The application letter must include: (1) full name of applicant (with surname underscored); (2) home and school addresses; (3) date and country of birth; (4) present citizenship; (5) complete transcript of courses and grades; (6) a one-page typewritten statement of the professional goals and interests of the applicant; (7) the applicant must solicit letters of reference from three college professors who know his work well, at least two of whom must be in his professional field (letters of recommendation should be sent directly to Dr. S. Fred Singer, Dean, School of Environmental and Planetary Sciences, University of Miami, Coral Gables, Florida 33124, U.S.A.); (8) marital status of the student and, if married, if he will be accompanied by his wife. (No additional support is available for the wives of participants, but accommodations are available to married couples.) (9) If the applicant is a resident of a country where the official language is other than English, the application should be accompanied by a statement by a university professor teaching the English language or by an official designated by a United States Embassy or Consulate certifying that the applicant can read, write, and speak English fluently.

Deadline for the receipt of applications is May 1, 1966.

FORM LETTER TO ACCEPTABLE PARTICIPANTS

Dear Mr./Miss :

I am very pleased to advise you that the Academic Committee of the Summer School on Environmental and Planetary Sciences has recommended you for the award of an all-expense paid scholarship to enable you to participate in the Summer Course in Environmental and Planetary Sciences at the University of Miami.

Your scholarship includes $60.00 per week as the subsistence allowance which should cover all your expenses, a round-trip travel allowance and full tuition. You will receive a round-trip airline ticket, but you are expected to make your own reservations. Should you prefer some other means of transportation, you will be reimbursed an equivalent of the airline fare.

I hope that you are able to take advantage of this opportunity, and I would urge you to communicate your acceptance by letter or wire to me before 24 May, 1966. In the event you have other plans for the summer, you will greatly benefit another fellow student if you will promptly advise me of your inability to accept the scholarship.

Sincerely yours

K.P. Chopra
Associate Director
Summer School on Environmental
and Planetary Sciences

FORM LETTER TO ACCEPTABLE - ALTERNATE APPLICANTS
(On Waiting List)

Dear Mr/Miss :

The Academic Committee of the Summer School in Environmental and Planetary Sciences of the University of Miami has examined your application, transcripts and letters of recommendation on the basis of the scholastic requirements set up by the committee.

Because of the limited number of scholarships available this year, the committee is unable to offer you a scholarship at this time.

However, the committee has recommended that your name be placed on our waiting list, and should an additional scholarship become available, you will be informed by wire on or about 24 May, 1966.

Sincerely yours

K.P. Chopra
Associate Director
Summer School on Environmental
and Planetary Sciences

FORM LETTER TO NON-ACCEPTABLE APPLICANTS

Dear Mr./Miss :

The Academic Committee of the Summer Course in Environmental and Planetary Sciences has examined your application, transcripts and letters of recommendation on the basis of the scholastic requirements set up by them. Because of the limited number of scholarships available this year, the committee is unable to offer you a scholarship at this time.

However, we would encourage you to apply again for the next year's summer program.

We thank you very much for your interest in our program.

Sincerely

K.P. Chopra
Associate Director
Summer School in Environmental
and Planetary Sciences

FORM LETTER CONTAINING GENERAL INFORMATION TO PARTICIPANTS

Dear

The following information will help you plan your summer with us in Miami:

HOUSING

Air-conditioned dormitories are being provided for you and will be available from June 14th through July 24th. Four students will share these two bedroom dormitory apartments. Your apartment will be assigned upon your arrival at the campus where you should check in at the University Housing Office, Eaton Hall, 1211 Dickinson Drive, which is open each day from 8:00 A.M. until midnight. Your mail may be addressed to you in care of the University of Miami Housing Office for the first few days until you can notify your correspondents of your apartment number. For emergency commui ication you may advise your family that you may be contacted through the School of Environmental and Planetary Sciences, area code 305, telephone 661-2511, Ext. 3011, during day time hours.

SCHEDULE

You should plan to arrive on the University of Miami campus no later than June 16th. The first formal meeting of the class will be at 9:00 A.M., June 17th, in Room 101 of the Computing Center Building. Classes will meet Monday through Friday from 9:00 until 11:00 in the morning and the afternoon session is usually from 1:00 until 3:00, and will be interspersed withtours and field trips. The last scheduled day of the program will be July 22.

CLOTHING AND PERSONAL EFFECTS

Casual summer attire will be acceptable for all activities planned for the students as a group, including field trips. Campus rules permit Bermuda shorts for boys but rule them out for girls, insisting girls wear skirts in class rooms and the library. Zories or thong sandals are frowned on for campus wear. Swimming, tennis, sun bathing, skin diving, sailing and other outdoor sports are at their peak in the summer months in Miami, so be sure and include adequate sportswear in your wardrobe. There will be many opportunities for amateur photographers, so bring your camera.

FOOD

Facilities are available at the University of Miami Student Union Cafeteria and meal tickets are available to students who wish them. The meal tickets provide a 10% discount and are sold in $40.00 face value books. Other facilities available at the Student Union include a large swimming pool, bowling alley, ping pong tables, snack shops and a lounge.

RECOMMENDED TEXTBOOKS

The following textbooks are recommended for your consideration or purchase:

Introduction to Theoretical Meteorology, Seymour L. Hess; Henry Holt and Co., (1959)

Physics of Ionized Gases, Lyman Spitzer, Jr. 2nd Edition Interscience Publishers, New York (1956)

Introduction to Oceanography , Jerome Williams

SUBSISTENCE

Your scholarship includes $60.00 each week as a subsistence allowance which should cover all your expenses. The dormitory charges (rent plus linen) will be $59.50 for the summer term. One fifth of this amount $11.90 will be deducted from each of your stipend payments, unless you choose not to live in the University of Miami dormitories. If you wish to purchase cafeteria meal tickets through the school, one-half of the cost of such a ticket will be deducted from two consecutive week's stipend checks. The stipend check will normally be disbursed to the participants on Friday afternoon of each full week of the session.

Sincerely,

K.P. Chopra
Associate Director
Summer School of Environmental
and Planetary Sciences

KPC/f

APPENDIX 2

LIST OF STUDENT PARTICIPANTS

LIST OF STUDENT PARTICIPANTS

NAME	UNIVERSITY	HOME ADDRESS
Victor J. Bellino	Villanova University	1443 Grovania Avenue Abington, Pennsylvania 19001
Richard C. Benigni	Boston College	3121 Buchanan Street San Francisco, California
George L. Berish	Norwich University	25 Windsor Road Huntington, Connecticut
Daniel R. Bunce	Otterbein College	27 Schrock Road Westerville, Ohio
Juan Carlos Busti	Columbia University (Graduate, B.S.)	515 Alminar Avenue Coral Gables, Florida 33146
Bruce N. Carney	Clarion State College	8790 Remington Drive Pittsburgh, Pennsylvania
Keith Carson	Jacksonville University	6040 Columbine Drive Jacksonville, Florida
David Evan Cooper	University of Miami	200 C Street, S.E. Washington, D.C. 20013
Jerry Dean Davenport	Southern University	805 West 30th Avenue Covington, Louisiana
John A. Disney	Hanover College	Box 228 Hanover, Indiana
Landy Nelson Doyel	Arkansas Polytechnic	Route 2 Ozark, Arkansas
John C. Foster	Boston College	206 Elmtree Road Rochester, New York 14612
Brian J. Gallagher	University of Wisconsin	2662 N. 47th Street Milwaukee, Wisconsin 53210
Santiogo Gangoteno	Auburn University	372 W. Glenn Avenue Apartment E Auburn, Alabama 36830
Susan Louise Geisel	Trinity College	5915 Emilie Road Levittown, Pennsylvania 19057

NAME	UNIVERSITY	HOME ADDRESS
Kurt J. Henle	University of Bridgeport	115 Beach Avenue Milford, Connecticut
Marshall Y. Huang	Occidental College	1101 W. Alhambra Road San Gabriel, California
Torrence V. Johnson	Washington University St. Louis	55 Fort Brown Brownsville, Texas 78520
Stephen O. Larson	University of North Dakota	Barton, North Dakota
Gregory W. Morrissey	Holy Cross	92 Gettysburg Street Bellerose, New York
Phillip R. Peterson	Idaho State University	39 Hawthorne Avenue Pocatello, Idaho
Robert J. Robinson	Tarleton State College	Route 3, Box 144 Weatherford, Texas 76086
James R. Shirck	Midland College	102 East 8th Street Ellis, Kansas 67637
Piran Sioshansi	Purdue University	23 Khazen Street Sanaqi Avenue Tehran, Iran 103 University Street West Lafayette, Indiana 47906
Ralph Spires	Jacksonville University	2312 Leonid Road Jacksonville, Florida 32218
Leonard A. Stein	University of Miami	2263 S.W. 16th Terrace Miami, Florida
Thomas A. Weaver	Colgate University	26 Alma Rock Road Stamford, Connecticut
Robert N. Wolfson	Lawrence University	2157 Ridge Avenue Evanston, Illinois
Alain W. Wouters		77, Chemin des Templiers Champles - Wavre, Belgium
Charles Chi-Chao Wu	Tulsa University	9/Fl. A, Kapol Mansion Tsuen Wan, HongKong
Simon Shin-Lun Yu	Seattle-Pacific College	P.O. Box 1261 HongKong

NAME	UNIVERSITY	HOME ADDRESS
Harro Zimmer	Wilhelm Foerster Sternwarte Mit Zeiss-Planetarium Berlin	1 Berlin 61 Meringdamm, Germany
Ben-Ami Zour	University of Miami	1217 Dickinson Drive Apartment 49J Coral Gables, Florida
Roberto V. Calheros	National Research Council Department of Aeronautics	Brazil
Isaisas P. Mock	University of Panama	P. O. Box 1044 Panama
Trevor Wayne Lue	University of Jamaica	Jamaica
Donald Roy Walwyn	University of Jamaica	Jamaica
Evan Ciner	University Nacional de Cuyo	Observatorio Astronomico Felix Aguilar Marquezado - San Juan Rep. Argentina
Gaston Mejia	University of LaPaz	Pedro Zalazar 607 LaPaz, Bolivia
Alexander Toporkov	University Nacional deLaPlata	Argentina

APPENDIX 3

RECRUITMENT OF FACULTY

FORM LETTER OF INVITATION TO FACULTY PARTICIPANT

Dear Dr./Professor :

In continuation of our earlier telephone conversation, I am very happy to extend an invitation to you to participate in our Summer School on the "Fundamental Concepts in Environmental and Planetary Sciences".

The objective of this summer school is to stimulate the interests of undergraduates at Senior and Junior levels in seeking advanced studies and careers in environmental sciences. The class consists of above-average under-graduates who are awarded all-expense paid scholarships. The objectives of the course will be well served if these students are exposed to currently active research problems at descriptive or conceptive levels.

We would like you to give ------ one-hour lectures on ----------. These lectures are scheduled as follows:

I shall greatly appreciate receiving the following information concerning your lectures:

1. More exact title of your lecture
2. Out-line (list of topics and sub-topics)
3. Any suggested reading material, and
4. One or two multiple choice or yes-no type questions for the final examination.

We shall reimburse you for your travel expenses, and in addition, we shall pay you an honorarium of --------- to cover your local (hotel, etc.) and other expenses connected with your participation in our program.

I certainly look forward to seeing you soon. With my best personal regards, I remain

Cordially yours

K.P. Chopra
Associate Director
Summer School on Environmental
and Planetary Sciences

P.S. We shall be happy to make your travel and local arrangements in Miami or assist you in any possible way.

cc: Dr. Douglas Duke

FORM LETTER OF THANKS TO PARTICIPATING FACULTY

Dear Dr./Professor :

We are most grateful to you for taking time from your very busy schedule to participate in our Summer School on the "Fundamental Concepts of Environmental and Planetary Sciences".

Your lectures were exceptionally well received by the students who found the subject matter and it's presentation quite informative and very stimulating. We feel that your discourse created a lasting impression on the students. We also hope that your participation in our program was as rewarding to you as it was for those in your audience.

We feel that you made a major contribution to the success of our summer school program, and we sincerely believe that we shall continue to receive your help and cooperation in our future ventures of similar nature.

Once again, I would like to take this opportunity to thank you on behalf of the University of Miami and myself.

With my best personal regards, I remain

Very cordially yours

K.P. Chopra
Associate Director
Summer School of Environmental
and Planetary Sciences

cc: Dr. Douglas Duke

APPENDIX 4

LIST OF FACULTY PARTICIPANTS

1. GENERAL LECTURES

(a) Opening Session

Dr. M. Robert Allen, Dean
Division of Continuing Education
University of Miami

Dr. K. Chopra, Associate Director
Summer School of Environmental and Planetary Sciences
University of Miami

Dr. R. Hanel, Chief Scientist
Laboratory for Atmospheric and Biological Studies
NASA's Goddard Space Flight Center

Dr. W. Smith, Director
Institute of Marine Science
University of Miami

(b) Closing Session

Dr. K. Chopra, Associate Director
Summer School of Environmental and Planetary Sciences
University of Miami

Dr. U. Liddel, Director
Planetary Sciences Program
NASA Headquarters

2. ASTROPHYSICS AND ASTRONOMY

Professor H. Anderson Rice University	X-ray, -ray and Cosmic ray Astronomy and Astrophysics (2 hours
Professor K.P. Chopra University of Miami	Our Universe - Introduction (2 hours)
Professor A. Dessler Rice University	Solar Wind and Interplanetary Magnetic Field (1 hour)
Professor D. Duke University of Miami	Introduction to Astronomy (2 hours)
Professor H. Laster University of Maryland	Cosmic Ray Astrophysics (2 hours)
Mr. C.P. Martens Institute of Defense Analysis	Solar Physics (2 hours)

Professor T. Page Harvard University	Galactic Structure (1 hour) Cosmology (1 hour) Stellar Energy Generation (1 hour)
Dr. F. Roach ESSA, Boulder, Colorado	Zodiacal Light (1 hour)
Professor P. Sconso IBM and Boston University	Minor Planets (1 hour)
Professor S.F. Singer University of Miami	Interplanetary and Interstellar Dust
Professor E.H. Walker University of Miami	Lunar Surface (1 hour)
Dr. U. Liddel NASA Headquarters	Solar System (1 hour)

3. EARTH SCIENCES AND METEORIC PHYSICS

Professor K.P. Chopra University of Miami	General (1 hour)
Professor K. Runcorn Newcastle University and University of Miami	Solid Earth Sciences (12 hours)
Professor F. Wickman Harvard University and University of Miami	Meteor Physics (3 hours) Geological Sciences (2 hours)

4. ATMOSPHERIC PHYSICS

Dr. L. Herrera-Cantilo University of Miami	Radar Observations in Meteorology (1 hour)
Professor K.P. Chopra University of Miami	Satellite Meteorology (1 hour) Mesometeorology (1 hour) Weather Modification (1 hour) Turbulence and Atmospheric Diffusion (1 hour)
Professor A. Dessler Rice University	Magnetosphere (1 hour)
Mr. H. Hawkins ESSA	Hurricanes (2 hours)

Professor S. Hess Florida State University	Introduction to Theoretical Meteorology (6 hours) Planetary Atmospheres (2 hours)
Dr. R. Hanel NASA	Space Probes and Planetary Atmospheres (1 hour)
Professor W. Hitschfeld McGill University	Cloud and Precipitation Physics (3 hours)
Lt. Com. Lawniczak U.S. Navy	Numerical Meteorology (1 hour)
Professor Y. Mintz U.C.L.A.	Numerical Simulation of Atmospheric Circulation and Climate on Earth and Mars (4 hours)
Dr. W. Nordberg NASA	Satellite and Rocket Meteorology (3 hours)
Professor G. Ostlund University of Miami	Hurricanes - Nuclear Tracer Studies (1 hour)
Professor E. Reiter Colorado State University	Synoptic Meteorology (2 hours) Jet Streams (1 hour) Turbulence (1 hour)
Dr. F. Roach ESSA	Light of Night Sky (1 hour) Airglow and Aurora (1 hour)
Professor S.F. Singer University of Miami	Planetary Radiation Belts (1 hour)
Dr. P.J. Wyatt Defense Research Corp.	Atmospheric Whistlers (1 hour)

5. OCEANOGRAPHY

Professor S. Broida University of Miami	Introduction to Oceanography (2 hours)
Professor J. Bunt University of Miami	Introduction to Ecology (1 hour)
Professor K.P. Chopra University of Miami	Satellite Oceanography (1 hour)
Professor G. Ewing Woodshole Oceanographic Institution	Satellite Oceanography (2 hours)

Professor M. Garstang Florida State University	Air-Sea Interaction at Synoptic-to-Large Scale (2 hours)
Professor W. Drost-Hansen University of Miami	Structure of Water and Ice (3 hours)
Professor R. Hurley University of Miami	Marine Geology (1 hour)
Dr. C. Idyll University of Miami	Fisheries
Professor J. Isaacs Scripps Institute of Oceanography	Air-Sea Interaction (4 hours)
Professor F. Koczy University of Miami	History of Sea Water (2 hours) Nuclear Oceanography (2 hours)
Lt. Com. Lawniczak U.S. Navy	Numerical Oceanography (1 hour)
Professor A. Myrberg University of Miami	Behavioral and Sensory Physiology of Some Marine Systems (1 hour)
Professor J. Prospero University of Miami	Geochronology (2 hours)
Professor W. Richardson Nova University	Gulf Stream (1 hour)
Professor P. Saunders Woodshole Oceanographic Institution	Infrared Thermometry (1 hour) Marine Marine Fog (1 hour)
Professor W. Smith University of Miami	Science and Oceans (1 hour)
Professor J. Steinberg University of Miami	Under Water Accoustics (1 hour)

APPENDIX 5

SCHEDULE OF LECTURES

June 17, 1966

8:45 ASSEMBLY - Room 101 - Computing Center Building

9:00 Welcome - Dr. Robert Allen, Dean of Continuing Education
University of Miami

SPEAKERS:

9:15 - Dr. Walton Smith
Director, Institute of Marine Science
University of Miami

Title: Science and Oceans

10:15 - Dr. R.A. Hanel
Chief Scientist, NASA
Goddard Space Flight Center
Greenbelt, Maryland

Title: Earth Satellites and Atmospheric Science

1:00 Assembly in Room 101 - Computing Center Building

Briefing on Summer Course by Dr. K.P. Chopra
Associate Director, Summer School of Environmental and Planetary Sciences

1:30 - 3:30 Tour of Computing Center
Radar Meteorology Laboratory - Mr. Homer W. Hiser
Head, Radar Meteorology Laboratory

5:00 - 6:00 RECEPTION - Meditation Garden
Ferre Building
Main Campus

WEEK OF JUNE 20 - THROUGH 24th

	MONDAY - June 20	TUESDAY - June 21	WEDNESDAY - June 22	THURSDAY - June 23	FRIDAY - June 24
9:00 A.M. to 9:45 A.M.	Dr. K. Chopra Galactic and Stellar Systems	Dr. K. Chopra Solar System	Dr. K. Chopra Mesometeorology	Dr. S.K. Runcorn Internal Constitution of the Earth	Dr. S.K. Runcorn Planetary Interior
9:50 A.M. to 10:40 A.M.	Dr. Seymour Hess Heat Budget of the Earth-Atmosphere System	Dr. Seymour Hess A complete System of Equations Governing the Atmosphere	Dr. Seymour Hess General Circulation of the Atmosphere	Dr. Seymour Hess Atmosphere of Venus	Dr. A. Myrberg Oceanography
11:00 A.M. to 11:50 A.M.	Dr. Seymour Hess A complete System of Equations Governing the Atmosphere	Dr. Seymour Hess A complete System of Equations Governing the Atmosphere	Dr. Seymour Hess General Circulation of the Atmosphere	Dr. Seymour Hess Atmosphere of Venus	Dr. A. Myrberg Oceanography
1:30 P.M. to 2:20 P.M.	Dr. S. Broida Physical Oceanography	Dr. K. Chopra Planetary Atmospheres - Nomenclature	Dr. Douglas Duke Physical Astronomy	Dr. M. Garstang Fundamentals of Energy Exchange between the Ocean and Atmosphere	TOUR Institute of Marine Science
2:30 P.M. to	Dr. S. Broida Physical Oceanography	Dr. K. Chopra Planetary Atmospheres - Theoretical Models	Dr. Douglas Duke Observational Astronomy	Dr. M. Garstang Planetary Distribution of Energy Flux	TOUR Institute of Marine Science

WEEK OF JUNE 27 - THROUGH JULY 1

	MONDAY - June 27	TUESDAY - June 28	WEDNESDAY - June 29	THURSDAY - June 30	FRIDAY - July 1
9:00 A.M to 10:00 A.M	Dr. S.K. Runcorn Geomagnetic Field and its Analysis	Dr. S.K. Runcorn Electrical Conductivity of the Earth	DR. S.K. Runcorn Solar and Planetary Mahnetism	Dr. S.K. Runcorn Variable Rotation of the Core and Mantle	Dr. S.K. Runcorn Theory of the Main Geomagnetic Field
10:00 a.m to 10:50 a.m	Dr. W. Drost-Hansen Structure of Water	Dr. W. Drost-Hansen Structure of Water	Dr. W. Drost-Hansen Structure of Ice	Dr. van de Boogaard Tropical Meteorology	Dr. P.J. Wyatt Atmospheric Whistlers
11:00 a.m. to 11:50 a.m.	Dr. P. Sconzo Minor Planets and their theoretical and astro-nautical importance	Mr. C. Martens Survey of the structure of the solar atmosphere	Mr. C. Martens Solar Activity	Dr. Hugh Anderson X-Ray and γ-Ray Astronomy	Dr. Hugh Anderson X-Ray, γ-Ray, Cosmic Ray Astrophysics
1:30 p.m. to 2:20 p.m.	Lt. Com. Lawniczak				

WEEK OF JULY 4 THROUGH JULY 8

	MONDAY - July 4	TUESDAY - July 5	WEDNESDAY - July 6	THURSDAY - July 7	FRIDAY - July 8
9:00 a.m. to 9:50 a.m.	HOLIDAY	DR. F.E. Wickman Chance and Geology	Dr. F.E. Wickman Chance and Geology	Dr. S.K. Runcorn Paleomagnetism, Palaeorotation of the Earth	Dr. S.K. Runcorn Stellar and Cosmic Magnetism, Geo-magnetic Reversals
9:50 a.m. to 10:50 a.m.		Dr. T. PAGE Astrophysics	Dr. J. Isaacs Air-Sea Interaction	Dr. J. Isaacs Air-Sea Interaction	Dr. P. Saunders Infra-red Thermometr
11:00 a.m. to 11:50 a.m.		Dr. F. Roach Light of Night-Sky	Dr. F. Roach Air-Glow And Aurora	Dr. F. Roach Zodiacal Light	Dr. P. Saunders Marine Fog
1:30 p.m. to 2:20 p.m.		Dr. S.F. Singer Interplanetary and Interstellar Dust	Dr. J. Isaacs Air-Sea Interaction	Dr. J. Isaacs Air-Sea Interaction	TOUR U.S. Weather Bureau
2:30 p.m. to 3:20 p.m.		Dr. S.F. Singer Planetary Radiation Belts	Dr. T. Page Astrophysics	Dr. T. Page Astrophysics	TOUR U.S. Weather Bureau

WEEK OF July 11 THROUGH July 15

	MONDAY July 11	TUESDAY - July 12	WEDNESDAY - July 13	THURSDAY - July 14	FRIDAY - July 15
9:00 a.m. to 9:50 a.m.	Dr. F.E. Wickman Applications of Meteoric Studies	Dr. F.E. Wickman Application of Meteoric Studies	Dr. S.K. Runcorn Palaeo-climatology	Dr. F.E. Wickman Meteoritic Craters	Dr. S.K. Runcorn Continental Drifts
10:00 a.m. to 10:50 a.m.	Dr. H. Laster Cosmic-Ray-Astro-physics	Dr. H. Laster Cosmic-Ray-Astro-physics	Dr. E. Reiter Synoptic Meteorology	Dr. J. Steinberg Underwater Accoustics	Dr. W. Hitschfeld Severe Storms
11:00 a.m. to 11:50 a.m.	Dr. S.K. Runcorn Theory of Magnetism and application to Rocks	Dr. E. Reiter Turbulence and Jet Stream	Dr. E. Reiter Synoptic Meteorology	Dr. R. Hurley Marine Geology	Dr. W. Nordberg Satellite Meteorology
1:30 p.m. to 2:20 p.m.	Dr. J. Bunt Ecology	Dr. Chopra Satellite Oceanography	Dr. C. Idyll Fisheries	Dr. W. Hitschfeld Precipitation and Cloud Physics	Dr. K. Chopra Satellite Meteorology
2:30 p.m. to 3:20 p.m.	Dr. H. Walker Lunar Surface	Dr. K. Chopra Seismology	Dr. L. Herrera-Cantilo Radar Observation in Meteorology	Dr. W. Nordberg Satellite Meteorology	Dr. Richardson Gulf Stream

WEEK OF JULY 18 - THROUGH JULY 22nd

	Monday - July 18	TUESDAY - July 19	WEDNESDAY - July 20	THURSDAY - July 21	FRIDAY - July 22
9:00 A.M. TO 9:45 A.M.	Dr. Y. Mintz Numerical Meteorology	Dr. Y. Mintz Numerical Modelling of Planet Mars' Atmosphere	EXAMINATION	TRIP TO CAPE KENNEDY Leave 6:00 A.M.	
9:50 A.M. to 0:40 A.M.	Dr. Y. Mintz Numerical Meteorology	Dr. K. Chopra Micrometeorology Atmospheric Turbulence and Diffusion			
11:00 A.M. TO 11:50 A.M.	Dr. A. Dessler The Solar Wind and Interplanetary Mag-netic Field	Dr. F. Koczy History of Ocean Water			
1:30 P.M. to 2:20 P.M.	Dr. A. Dessler The Magnetosphere	2:00 - Dr. U. Lidell Solar System			
2:30 P.M. to 3:20 P.M.	Dr. F. Koczy Nuclear Oceanography	3:00 - Dr. K. Chopra Concluding Remarks			

APPENDIX 6

OUTLINES OF LECTURES

APPENDIX 6

PART I

ASTRONOMY, ASTROPHYSICS AND SPACE SCIENCE

Hugh R. Anderson
Department of Space Science
Rice University, Houston Texas

Lecture #1: X and γ-Ray Astronomy:

I. Transmission and Absorption of Electromagnetic Radiation by the Atmosphere

A. Classification of the electromagnetic spectrum

B. Atmospheric windows

We can "see" outer space in visible light, some infrared wavelengths, and at some radio wavelengths. At all other wavelengths the sky is black. The atmosphere stops charged particle radiation also.

II. Mechanisms Which Can Produce X and γ-rays

A. Thermal emission from very hot bodies. (Black body emission)

B. Bremsstrahlung

C. Synchrotron emission

D. Atomic X-ray line emission

E. Nuclear γ-ray emission

F. Inverse Compton collisons

III. Experimental Technique

A. Oriented sounding rockets

B. Satellites

C. Balloons

IV. Potential and Observed Sources

A. Sun
X-rays, no γ-rays

B. Moon
No flux observed

C. Planets, especially Jupiter
No flux observed

D. Galactic background
X-rays
Possibly γ-rays

E. Discrete sources
Not optically identified — X-rays observed
Crab Nebula — No γ-rays to date

SUGGESTED READING MATERIAL

Hafner, E. M., Science 145, 1263-1271 (1964)

Hayakawa et al., Space Science Reviews 5, 109-163 (1966)

Lecture #2: Cosmic Ray Astrophysics:

I. Two Types of Energetic Particle Radiation in Interplanetary Space

A. Solar cosmic rays
Typical spectra and time history
Modulated by interplanetary medium

B. Galactic cosmic rays
Typical spectra
Modulated by interplanetary medium

II. Relationship to Other Areas of Research

The study of cosmic rays has been and/or is related to research in several other areas which are outlined below.

A. The interaction of high energy particles and the nature of the unstable, elementary particles:

1. Positrons, π and μ mesons, and some heavier particles were discovered among cosmic ray secondaries in the atmosphere.

2. Some of the processes explained by quantum electrodynamics such as pair production, and positron annihilation were first observed in the electron-photon cascade.

3. Currently cosmic rays are the only source of particles with energies above $\sim$30 Bev.

B. Various effects of the action of cosmic rays on matter and on the geomagnetic field

1. Radioactive nuclei and spallation products are produced in meteors when cosmic rays bombard them in space. From the distribution of these elements in fallen meteorites it is possible to estimate

   a) The size of the meteor before it passed through the atmosphere

   b) The age of the meteor

2. Cosmic ray secondary neutrons produce C^{14} in the atmosphere. By measuring the distribution and concentration of this isotope it is possible to

   a) Calculate the length of time organic material has been dead

   b) Estimate the rate at which the atmosphere circulates and mixes with the biosphere and oceans

3. The distribution of cosmic rays over the earth results from the configuration of the geomagnetic field. Changes in the latter can be deduced from changes in the former.

4. Upward moving cosmic-ray secondaries which decay in flight are one source of trapped radiation.

C. Processes in the outer portion of the sun and in interplanetary space

1. The composition of solar cosmic rays is related to the composition of the sun, where the particles are accelerated.

2. The energy spectra and temporal variations of solar cosmic rays are intimately related to the processes in sunspots and other active regions of the sun. Models of solar activity must account for cosmic rays as well as the radio, optical, and X-ray bursts from the sun.

3. The interplanetary magnetic field determines the time variations of solar cosmic rays at the earth in part and, it is thought, causes all the temporal variations observed in galactic cosmic rays.

D. Extra-solar astrophysical processes

1. The energy density of galactic cosmic rays is ~ 1 ev/cm^3 and is about equal to that of starlight and of the estimated interstellar magnetic field. Thus, depending upon cosmic ray lifetime, a significant amount of stellar energy may go into accelerating cosmic rays.

2. Galactic cosmic rays provide the only direct sample of extra-solar system nuclear abundance. The abundance is determined by the source of the rays and by the amount of matter with which they have collided since acceleration.

3. The energy spectrum and isotropy is related to the interstellar magnetic field strength.

4. The galactic electron spectrum must agree with the measured synchrotron radio noise from the galaxy.

III. Variations of Cosmic Rays

A. Production at the sun and relationship of production to other solar activity

B. Modulation of radiation reaching the earth's surface

1. Atmospheric

2. Geomagnetic

C. Modulation by the interplanetary medium

1. Anisotropy

2. Short term Forbush modulation

3. 11 year modulation

SUGGESTED READING MATERIAL

Singer, S. F., Progress in Cosmic Ray Physics IV, 203-335, N. Holland Publishing Co., Amsterdam, 1958.

Webber, W. R., Progress in Cosmic Ray Physics VI, 75-244, N. Holland Publishing Co., Amsterdam, 1962.

Hooper, J. E., and M. Scharff, The Cosmic Radiation, Methuen and Company, Ltd., London, 1958.

Dr. Kuldip P. Chopra
Institute of Atmospheric Science
University of Miami, Coral Gables, Florida

Lecture #1: Our Universe: Galactic and stellar systems. Galaxies, stars, planets and satellites. Astronomical units of length. Milky way. Russel diagram. Mass-luminosity relationship. Magnetic and radio stars. Quasi-stellar sources. Inter-stellar space, 21 cm line.

Lecture #2: Solar System: Solar system, its regularities and irregularities, Bode's Law. Sun: its interior and atmosphere, sun-spots and other surface features. Temperature in the corona. Solar flares.

Lecture #3: The Sun: Laws of radiation. Significance of Planck's law of radiation. Solar constant and its determination. Estimate of black-body temperature of Sun's surface. Sun as a black body. Sun as a Star. Solar corpuscular and electromagnetic radiation: solar wind and solar breeze.

Lecture #4: Magnetohydrodynamics and Its Astrophysical and Geophysical Applications: Fundamentals: basic equations. Characteristic magnetohydrodynamic parameters: analogs of Reynolds number. Magnetic Reynolds number: its significance. Induction drag; electrostatic and electromagnetic shielding effects. Flow in channels and pipes. Magnetohydrodynamic boundary layer. Galactic magnetic field, its estimate from magnetohydrodynamic considerations. Magnetohydrodynamic dynamo. Theories of sun-spots, magnetic stars and Earth's magnetic field.

Lecture #5: Plasma Physics and Some Astrophysical and Geophysical Applications: what is a plasma? Motion of charged particles in electric and magnetic fields. Magnetic moment of a spiralling charged particle, its adiabatic invariant, the mirror effect. Acceleration of charged particles; Fermi mechanism.

Lecture #6: Comets: What are comets? Structure of a comet: nucleus, coma and tails. Orbital characteristics of comets; trapping and escape of a comet. Comet statistics. Theories of comet tails; interaction with solar wind. Theories of origin of comets.

Lecture #7: Space Vehicles: Orbits of earth satellites. Drag on a satellite in a neutral atmosphere. Vertical density profile from orbits of earth satellites. Space Vehicles in ionized media: body potential, charged particle clouds, excitation of plasma and magnetohydrodynamic waves. Additional drag mechanisms.

SUGGESTED READING MATERIAL

K. P. Chopra: Lecture Notes

K. P. Chopra: Reviews of Modern Physics 33, 153 (1961)

L. H. Aller: Astrophysics, Michigan University Press

H. Alfven: Cosmical Electrodynamics, Chapter IV (Oxford: at the Clarendon Press)

T. G. Cowling: Magnetohydrodynamics (Interscience)

S. Chandrasekhar & E. Fermi: Astrophysical Journal 118, 113 (1953)

L. Spitzer: Physics of Fully Ionized Gases (Interscience)

Dr. Alexander J. Dessler
Department of Space Science
Rice University, Houston, Texas

THE SOLAR WIND AND INTERPLANETARY MAGNETIC FIELD

Historical introduction.

Supersonic expansion: general considerations

Supersonic expansion of the solar corona

Interplanetary magnetic field

The ultimate fate of the solar wind and the interplanetary magnetic field

SUGGESTED READING MATERIAL

A. J. Dessler: Solar Wind and Interplanetary Magnetic Field (Rice University, Department of Space Science Technical Report, July, 1966).

Dr. Douglas Duke
Institute of Atmospheric Science
University of Miami, Coral Gables, Florida

Lecture #1: <u>Orbits of Earth Satellites</u>:

Kepler's Laws

Newtonian gravitation

Elliptic motion

Perturbations due to oblateness

Atmospheric drag

Errors due to station location and instrumentation

Lecture #2: <u>Distances of Astronomical Objects</u>

Trigonometric parallax of stars

Measurement of the astronomical unit

Cepheid variable stars and period-luminosity relation

Galactic rotation

Distances to other galaxies

Dr. Howard Laster
Professor and Chairman
Department of Physics and Astronomy
University of Maryland, College Park, Maryland

Lecture #1: The Primary Cosmic Radiation:

Composition

Most primary cosmic rays are highly energetic nuclei of atoms. Their relative abundances are vaguely similar to the universal abundances of the elements, but with some significant differences. In addition, some primary electrons, positrons, and photons have been observed.

Energy

Primary cosmic rays are observed over an energy range of 10^9 - 10^{20} electron volts per particle. Over much of this range, they are incident with an approximate differential spectrum $\eta \alpha E^{-2.5}$. Deviations occur at the lower end of the range and also at the highest energies.

The energy density of cosmic rays in the neighborhood of our sun seems to be approximately 1 ev/cm^3. This is comparable with the energy density of starlight, turbulent galactic gas motion, and the galactic magnetic field.

Directional Effects

The earth's and the interplanetary magnetic fields profoundly affect the paths of low energy (1 - 30 Bev) cosmic rays. Higher energy particles appear to come in isotropically.

Time Variations

At low energies, cosmic ray intensities fluctuate noticeably. These changes can loosely be correlated with the solar-cycle and with solar disturbances. At higher energies, no significant variations have yet been established.

Lecture #2: Speculations About the Origins of Cosmic Rays:

One can attribute some cosmic ray phenomena to solar effects. However, it is now clearly established that an appreciable component comes from outside the solar system. Some theories explain cosmic rays as originating in ordinary stars and accelerating to high energies while diffusing in the galaxy. Others have them originating in flare stars, novae, and/or supernovae. Still other theories suggest that they come from the center of our galaxy, from outside radio galaxies, from quasi-stellar radio sources, or from cosmological sources. The various possibilities are discussed and compared with new cosmic ray and astronomical data.

SUGGESTED READING MATERIAL

Wolfendale: Cosmic Rays (Philosphical Library)

Ginzburg and Syrovatskii: The Origin of Cosmic Rays (Pergamon Press)

Morrison, others: Articles in Handbuch der Physile, Vol. 46 (1961)

Sandage: Quasi-Stellar Galaxies, Astrophysical Journal, p. 1560-1579, (May 15, 1964)

Proceedings of the Jaipur Conference on Cosmic Rays, Volumes 1-6 (1965)

Mr. Charles P. Martens
Institute for Defense Analyses
Arlington, Virginia

Lecture #1: Survey of the Structure of the Solar Atmosphere:

I. Definitions

1. The solar Atmosphere

a. Composition of solar gases

b. Opacity of solar atmosphere

2. The Quiet Sun

II. The Lower and Middle Levels of the Solar Atmosphere

1. Photosphere

a. Convection and granulation

b. Temperature and density profiles

2. Chromosphere

a. Temperature and density profiles

b. Spectral line formation

III. The Corona

1. Interface between corona and chromosphere

2. Coronal temperature profile and heating

IV. The General Magnetic Field of the Sun

Lecture #2: Solar Activity:

I. The Solar Cycle

II. Centers of Activity

1. Sunspots

a. Temperature and spectrum

b. Magnetic field

c. Inhibition of convection by sunspot magnetic field

d. Faculae

2. Plages

3. Flares

   a. Phenomenology of flares

   b. Energy release in flares

   c. Physical models of flares

III. Prominences

   1. Classification of prominence

   2. Models of prominences

IV. Coronal Activity

Dr. Thornton Page
Harvard and Smithsonian Observatories and
Wesleyan University
Cambridge, Massachusetts

Lecture #1: The Milky Way and Other Galaxies:

A. Review of Distance Measurements

1. Trigonometric parallax

2. Spectroscopic parallax, Cepheid variables

B. Interstellar Material

1. Nebular

2. Reddening and obscuration

3. "Fixed" absorption lines

C. Globular clusters and the Milky Way nucleus

D. Rotation of the Milky Way; its mass

E. Other galaxies

1. Types, distances, local group

2. Obscuration

3. Rotation

SUGGESTED READING MATERIAL

Abell: Exploration of the Universe, Chapters 16, 17, 22, 25, 26

Page and Page: Wanderers in the Sky, Chapters 1, 3

Lecture #2: Nuclear Energy and Stellar Evolution:

A. Spectral types; surface temperatures, H-R diagram

B. The Sun

1. Solar constant; luminosity

2. Atmosphere; spectral type

3. Interior conditions

C. Nuclear reactions in stars

1. Proton-proton

2. Carbon-nitrogen cycle

3. Helium "burning"

D. Star formation and evolution

1. Collapse of gas cloud

2. Life on main sequence

3. Supernova explosions, radio sources

4. Cycle of gas-stars-gas

E. Nucleogenesis

SUGGESTED READING MATERIAL

Abell: Exploration of the Universe, Chapters 23, 27, 28, 29

Page and Page: Origin of the Solar System, Chapters 1, 2, 3, 6, 7

Lecture #3: <u>The Evolution of Galaxies, and Cosmology</u>:

A. Counts of galaxies

1. Zone of avoidance

2. Number vs. brightness; distances, average luminosity

3. Groups and clusters

B. Redshifts vs. distance; cosmological principle

C. Differences in motion

1. Rotations and masses

2. Orbits of pairs

3. Motions in clusters

4. Average density of the universe

D. Evolutionary theories; explosions and quasars

E. Theories of Cosmology

1. Big-Bang; age of the universe

2. Steady-state; extended cosmological principle

SUGGESTED READING MATERIAL

Abell: Exploration of the Universe, Chapters 21, 32

Astron. Soc. of Pacific Leaflets No. 400 (Struve: Radio Galaxies)
421 (Page: Quasars)
429 (Bowen: Use of 200-inch Telescope)
433 (Page: Evolution of Galaxies)
435 (Hodge: Elliptical Galaxies)

Page: Evolution of Galaxies in Sky and Telescope (Jan.-Feb., 1965)

Dr. F. E. Roach
Institute for Telecommunication
Sciences and Aeronomy - ESSA
Boulder, Colorado

THE ASTRONOMICAL LIGHT OF THE NIGHT SKY

The Zodiacal Light; visual and measured, and interplanetary dust.

The integrated starlight

Diffuse Galactic Light and interstellar dust

Diffuse Cosmic Light and Cosmology

SUGGESTED READING MATERIAL

C. T. Elvey and F. E. Roach: A Photoelectric Study of the Light of the Night Sky, Astrophys. J., 85:213, 1937.

L. L. Smith, F. E. Roach and R. W. Owen: The Absolute Photometry of the Zodiacal Light, Planetary and Space Science, 13:207, 1965.

F. E. Roach and L. L. Smith: An Observational Search for Cosmic Light, (In manuscript).

F. E. Roach: The Light of the Night Sky; Astronomical, Interplanetary and Geophysical, Space Science Reviews, 3:512, 1964.

F. E. Roach: Diffuse Galactic Light, Stowe Memorial Volume (in press).

Professor P. Sconzo
IBM Corporation and Boston College
Cambridge, Massachusetts

MINOR PLANETS AND THEIR THEORETICAL AND ASTRONAUTICAL IMPORTANCE

Historical review from the discovery of the first M. P. to the present age.

Problems of celestial mechanics arising from the study of the motion of M. P. Theory of planetary perturbations. General perturbations and special perturbations.

Preliminary and definitive orbit computation. Catalogue of M. P. Ephemeris.

Organization of the observations. Unusual orbits, in particular, the orbits of the so called Trojan planets. Closest approaches to earth. Statistical studies: distribution of the mean motion values and Kirkwood's gaps, distribution of eccentricity values, inclinations, perihelion longitudes and other characteristic elements.

Photometric studies. Size and mass.

Computation of the orbit of an interplanetary probe.

Astronautical uses of M. P.

Modern studies on universal and regularizing variables.

SUGGESTED READING MATERIAL

W. Corliss: Space Probes and Planetary Exploration. D. VanNostrand Co., Inc., N. Y., 1965.

S. Glasstone: Sourcebook on the Space Sciences. D. VanNostrand Co., Inc., N. Y., 1965.

R. L. Newburn: The Exploration of Mercury, the Asteroids, the Major Planets and Their Satellite Systems, and Pluto. Advances in Space Sciences and Technology, Vol. 3, F. I. Ordway, Ed., Academic Press. N. Y., 1961.

J. M. A. Danby: Fundamentals of Celestial Mechanics. The Macmillan Co., N. Y., 1962. (for orbit and perturbations theory).

Dr. Evan Harris Walker
Institute of Atmospheric Science
University of Miami, Coral Gables, Florida

THE LUNAR SURFACE

A. Current Lunar Problems

B. Lunar Craters

1. Description
2. Theories of origin

C. Crater Statistics

1. Distribution of craters as a function of time
2. The saturation distribution of craters
3. Secondary craters
4. Comparison of theory with Crater Counts

D. Theories of the Origin of the Lunar Maria

1. Lava flow
2. Impact and lava flow
3. Erosion fill-in of low areas
4. Impact crater
5. Impact - erosion

E. Lunar Subsurface

1. Wesselink's Measurement
2. Impact of Vehicles on the Moon

F. Information provided by Surveyor I and Luna 9

APPENDIX 6

PART 2

SOLID EARTH (PLANETARY) SCIENCES

Dr. K. P. Chopra
Institute of Atmospheric Science
University of Miami, Coral Gables, Florida

GENERAL LECTURE: Fundamental properties of rotation, gravitation and magnetism. Centrifugal and gravitational accelerations; the significance of their ration in the internal constitution of planets. Electromagnetic induction. Magnetohydrodynamic dynamo. Origin of Magnetic Fields and their variations.

RECOMMENDED READING MATERIAL

K. P. Chopra: Lecture Notes.

Dr. F. E. Wickman
Harvard University, Cambridge, Massachusetts
and
University of Miami, Coral Gables, Florida

Lecture #1: Chance and Geology I: Theories and mathematical models in geology. Deterministic and stochastic approaches to problems. Common types of stochastic processes.

Lecture #2: Chance and Geology II: Geologic examples: volcanic processes. Sedimentation and denudation processes. Uniformitarianism.

Lecture #3: Facts About Meteorites: The fall of meteorites, mineralogy, petrography and chemistry of meteorites.

Lecture #4: Theories About the Origin and Formation of Meteorites: Temperature indicators. Pressure indicators. Chemical relationships. The age of meteorites. Current theories of formation and origin.

Lecture #5: Meteoric Craters, Recent and Fossil: Impact frequency and crater formation. Tunguska event. Meteor crater. Criteria of impacts. The problem of fossil craters. Ries in Germany. Tektites. Impact formation as a geologic process.

SUGGESTED READING MATERIAL

Lectures 1 & 2: "Model building with the aid of stochastic processes" by H. Cramer in Technometrics, Vol. 6, pp. 133-159 (1964).

Lectures 3, 4 & 5: "Meteorites" by B. Mason, (John Wiley, 1962).

Professor R. K. Runcorn
University of Newcastle upon Tyne, England
and
University of Miami, Coral Gables, Florida

Lecture #1: Seismology: Seismometers. P, S, Rayleigh & Love earthquake waves. Determination of epicentres. Seismicity of the earth. Travel time curves. Variation of elastic constants with depth.

Lecture #2: Internal Constitution of the Earth: Tests of homogeneity of the mantle. Low velocity layer. Determination of mean density and moment of inertia of earth. Existence of core and inner body. Density models of earth.

Lecture #3: Planetary Interiors: Kepler's laws of motion. Determination of the masses, moments of inertia, radii, rotation periods and distances of the planets. The Darwin-Radau theory of the ellipticity of the planets. Constitution of terrestrial and major planets. Interpretation of Lunar and Martian surfaces.

Lecture #4: The Geomagnetic Field and Its Analysis: Measurements of the geomagnetic field at and near the earth's surface. Measurements of declination, inclination and intensity in historic times. Daily variation and annual variation of the geomagnetic field. Magnetic storms. Electromagnetic induction by varying external fields in a conducting sphere. Separation of internal and external parts of the transient geomagnetic variations by spherical harmonic analysis. Shielding of secular variation by mantle.

Lecture #5: Electrical Conductivity of the Earth: Radial variation of the electrical conductivity throughout the mantle. Explanation of observations by intrinsic semi-conduction. Experiments on silicates at high temperatures and pressures. Possible role of impurity and ionic conduction in the crust and upper mantle.

Lecture #6: Solar and Planetary Magnetism: Zeeman effect. Determination of magnetic fields and motion in sunspots. Solar magnetograph. Observations and theories of sunspots. The solar wind. Space vehicle measures of the fields of moon and inner planets. Non-thermal radio noise from Jupiter and Saturn.

Lecture #7: Variable Rotation of the Core and Mantle: The geomagnetic non-dipole and secular variation fields. Westward drift of the field and relative rotation of core and mantle. Irregular fluctuations in the length of the day. Electromagnetic coupling of the core and mantle. Rotation of Jupiter's Red Spot and radio sources.

Lecture #8: Theory of the Main Geomagnetic Field: Thermal convection in the earth's core: dominance of the Coriolis and electromagnetic forces. The dynamo theory of the origin of the field: twisting and creation of lines of magnetic induction by fluid motions. Model dynamos. Cause of reversals of polarity. Axial symmetry of mean geomagnetic field. The significance of the fields of Jupiter and Saturn and the absence of fields in Venus, Mars and the Moon.

Lecture #9: Theory of Magnetism and Its Application To Rocks: Anti-ferromagnetism and ferromagnetism. Remanent magnetization of rocks. Laboratory experiments for demonstrating thermo-remanent magnetization, isothermal remanent magnetization, viscous magnetization and chemical magnetization. Field and laboratory studies of the stability of rock magnetism.

Lecture #10: Palaeomagnetism and Continental Drift: Results of palaeomagnetic surveys in the various continents. Agreement with the dipole model in the last 20 million years. Reconstruction of continents for Mesozoic and Palaeozoic times as a test of Wegener's theory of continental drift.

Lecture #11: Palaeoclimatology and Palaeowind Directions: Permo-Carboniferous glaciation of Gondwanaland. Climatic indicators in the geological column: corals, red beds, evaporites. Comparisons with palaeomagnetic latitudes. Barchan and longitudinal sand dunes. Aeolian sandstones and determination of wind directions in geological past.

Lecture #12: Theory of Continental Drift: Convection current hypothesis. Relationship with world wide oceanic rift system, ocean trenches and heat flow. Low harmonics of the geoid. Non-elastic properties of the mantle. Marginal theory of convection. Thermal history of the earth. Convection in the Moon.

Lecture #13: Geomagnetic Reversals: Reversed magnetization. Occurrence in igneous, sedimentary and metamorphic rocks. Neel theories of self-reversals. Petrological correlations. Permian reversed magnetization. Age dating of Quaternary and Tertiary reversals. Reversals in ocean bottom cores.

Lecture #14: Stellar and Cosmic Magnetism: Zeeman broadening of lines from a star having a dipole field. Reversals of fields. Oblique rotator theory. Spectrum variables. Polarization of distant star light. Stability of galactic arms.

Lecture #15: Palaeo-rotation of the Earth: Secular acceleration of Moon and Sun in the last 200 years. Significance of ancient eclipse data. Lunar tidal friction. Annual variations. Changes in the earth's moment of inertia. Measurements of length of month and day in geological time by corals. Expansion of the earth.

SUGGESTED READING MATERIAL

Lectures 1 & 2: "Introduction to Theory of Seismology". K. E. Bullen (C.U.P., 1963). The Earth, 4th ed. H. Jeffreys, (C.U.P., 1962).

Lecture 3: "Basic Physics of the Solar System". V. M. Blanes & S. W. McCuskey (Addison-Wesley, 1961). The Planets, H. C. Urey, (Yale University Press, 1952).

Lecture 4: "Geomagnetism". 2 vols. S. Chapman & J. Bartels, (C.U.P., 1940).

Lectures 5, 7 & 8: "Electromagnetism and the Earth's Interior". T. Rikitake Elsevier 1966. The earth's core and geomagnetism. J. A. Jacobs (Pergamon Press, 1963).

Lectures 6 & 14: "Stellar and Solar Magnetic Fields". R. Lust (North-Holland, 1965).

Lecture 9: "Adv. in Physics". L. Neel (1955).
"Rock Magnetism". (T. Nagata Maruzen Co., Tokyo. 1964).

Lectures 10 & 12: "Continental Drift". S. K. Runcorn (Academic Press, 1965).
"A Symposium on Continental Drift". (Royal Society, London, 1965).

Lecture 12: "The Earth's Shape and Gravity". G. D. Garland (Pergamon Press).

Lecture 11: "Problems in Palaeoclimatology". A.E.M. Nairn (Interscience, 1963).

Lecture 13: "Palaeomagnetism". E. Irving, (McGraw-Hill, 1966).

Lecture 15: "Nature". S. K. Runcorn (October, 1965).
"The Rotation of the Earth". W. H. Munk & G.J.F. MacDonald (C.U.P., 1960).

APPENDIX 6

PART 3

ATMOSPHERIC SCIENCE

Dr. K. P. Chopra
Institute of Atmospheric Science
University of Miami, Coral Gables, Florida

Lecture #1: Nomenclature in Planetary Atmospheric Studies:

Temperature-based nomenclature: troposphere, stratosphere, mesosphere, and thermosphere; declines and inclines, lapse rates, pauses. Nomenclature based on chemical composition: ozonosphere, chemosphere. Nomenclature based on dynamical processes: homosphere, turbosphere, heterosphere, exosphere. Nomenclature based on electrical properties: neutrosphere, ionosphere, metasphere, protosphere, dust belt, radiation belts. Formation of peaks in distribution of a parameter; example: ozonosphere.

Lecture #2: Theoretical Atmospheric Models:

Concept of scale height. Uniform density atmosphere. Atmospheres in isothermal (conductive) adiabatic (convective), or diffusive equilibrium. Applications to Earth's atmosphere.

Lecture #3: Solar Radiation and Earth's Atmosphere:

Heating processes at different levels in the atmosphere. Heat balance. Green-house effect. Other physical and chemical processes involving solar radiation in the Earth's atmosphere.

Lecture #4: Mierometeorology:

Atmospheric turbulence and diffusion. Atmospheric boundary layer and vertical wind profile. Parameters determining reliability of measurements of wind speeds and directions.

Lecture #5: Mesometeorology:

Mesometeorological phenomena: eddies and eddy patterns; example: van Kármán vortex street patterns behind Madeira and Canary Islands. Cloud streets. Land-structure in hurricanes.

Lecture #6: Satellite Meteorology:

Satellite pictures and their interpretation. APT system. Current unsolved problems. Potential applications of satellite meteorology.

Lecture #7: Weather Modification:

Problems concerning weather modification. Various attempts: background, experimental detail and measure of success.

SUGGESTED READING MATERIAL

K. P. Chopra: Lecture notes.

Dr. A. Dessler
Department of Space Science
Rice University, Houston, Texas

THE MAGNETOSPHERE

Historical introduction

General hydromagnetic concepts pertaining to the solar wind and the magnetosphere

The shape of the magnetosphere

The magnetospheric tail - a controversy

Mr. Harry F. Hawkins
National Hurricane Research Laboratory-ESSA
Coral Gables, Florida

Lecture #1: Hurricanes:

Occurrence, tracks and descriptions

Lecture #2: Hurricane Structure and Some Possible Modification Hypotheses.

SUGGESTED READING MATERIAL

Dunn and Miller: Atlantic Hurricanes. Louisiana State Press, (1960)

Herbert Riehl: Tropical Meteorology. McGraw-Hill, (1954)

LaSeur and Hawkins: An Analysis of Hurricane Cleo (1958). Based on data from Research Reconnaissance Aircraft. Monthly Weather Review, Vol. 91, Nos. 10-12, pp. 694-709 (Oct.-Dec., 1963).

I. R. Tannehill: Hurricanes. Princeton University Press, (1956)

Dr. Seymour L. Hess
Department of Meteorology
Florida State University, Tallahassee, Florida

Lecture #1: <u>Heat Budget of the Earth-Atmosphere System</u>:

A. Overview of solar radiation, infrared radiation and infrared active gases in the atmosphere.

B. The heat budget of the earth-atmosphere system.

Lectures #2, 3, 4: <u>A Complete System of Equations Governing the Atmosphere</u>:

A. Conservation of energy

B. Conservation of mass

C. Conservation of momentum

Lectures #5,6: <u>The General Circulation of the Atmosphere</u>:

A. Background

B. Experimental approach

C. Numerical approach

Lectures #7, 8: <u>Atmosphere of Venus</u>

SUGGESTED READING MATERIAL

S. Hess: Introduction to Theoretical Meteorology. Sections 3.3, 10.7, 11.1, 11.2, 11.3, 11.4, 13.6, 21.1, 21.2, 21.3, 21.4, 21.6, 21.8. Holt-Drydon Co.

W. W. Kellogg and Carl Sagan: The Atmospheres of Mars and Venus. National Academy of Sciences, National Research Council Publication No. 944 (1961)

Dr. W. Hitschfeld
Department of Meteorology
McGill University, Montreal, Canada

Lecture #1: <u>The Formation and Precipitation of Clouds:</u>

A. Cloud formation:

1. Supersaturation

2. Condensation nuclei

3. Cloud droplet spectra

Precipitation:

1. The Bergeron-Findeisen process--snow generation and continuous precipitation in mid-latitudes

Coalescence

1. Warm rain

2. Thunderstorms

B Cloud radiation:

1. Cloud-free and cloudy global radiation balance

2. Are clouds thermodynamically black?

3. Measurement of the blackness of clouds: theory and experiment

Lecture #2: <u>Severe Storms</u>:

Hurricanes

Tornadoes

Squall lines

Thunderstorms -- with and without hail

Two hail storm types: the large, steady state storm; the small, relatively short-life cell

Physics of hail formation: Freezing nuclei, high-speed hail production, wet hail, hail trajectories, the decay of the hail cell.

SUGGESTED READING MATERIAL

B. J. Mason: Clouds, Rain and Rainmaking. Cambridge University Press (paperback)

TABLE I

Case	Ozone	Water vapour	CLOUD Base km	CLOUD τ %	CLOUD R %	CLOUD Temp C	Flux received*	Reflection correction*	Total flux*	Temp C
1	High	Med.	None				1.61		1.61	-72.9
2	Med.	"	"				1.63		1.63	-72.5
3	Low	"	"				1.53		1.53	-74.4
4	Med.	High	None				2.61		2.61	-57.8
5	"	Med.	"				1.63		1.63	-72.5
6	"	Low	"				0.93		0.93	-90(approx.)
7	Med.	Med.	0.07	0	0	+10.2	12.57		12.57	+10.2
8	"	"	1.13	0	0	+ 6.0	11.69		11.69	+ 6.2
9	"	"	3.3	0	0	- 6.4	9.44		9.44	- 5.0
10	"	"	5.5	0	0	-21.0	7.29		7.29	-17.6
11	"	"	8.3	0	0	-42.2	4.92		4.92	-34.5
12	Med.	Med.	8.3	0	0	-42.2	4.92		4.92	-34.5
13	"	"	"	25	0	"	4.11		4.11	-41.7
14	"	"	"	50	0	"	3.27		3.27	-50.0
15	"	"	"	75	0	"	2.45		2.45	-59.9
16	"	"	"	100	0	"	1.63		1.63	-72.5
17	Med.	Med.	0.07	0	10	+10.2	12.57	1.26	13.83	+15.6
18	"	"	1.13	0	10	+ 6.0	11.69	1.13	12.82	+11.3
19	"	"	3.3	0	10	- 6.4	9.44	1.02	10.46	+ 0.3
20	"	"	5.5	0	10	-21.0	7.29	0.99	8.28	-11.6
21	"	"	8.3	0	10	-42.2	4.92	0.96	5.88	-27.1
22	Med.	High	8.3	0	10	-47.7	6.06	0.95	7.01	-19.3
23	"	Med.	"	0	10	-42.2	4.92	0.96	5.88	-27.1
24	"	Low	"	0	10	-37.6	3.92	0.88	4.80	-35.5

*units are: watts m^{-2} per steradian

Lt. Cmdr. Lawniczak
Fleet Numerical Weather Facility
Monterey, California

NUMERICAL METEOROLOGY

Numerical methods for synoptic computation of circulation in the Earth's atmosphere.

SUGGESTED READING MATERIAL

Richardson: Weather Prediction by Numerical Processes. Dover Publication.

Dr. Y. Mintz
Department of Meteorology
University of California, Los Angeles, California

Lecture #1: Numerical Simulation of Circulation

Lecture #2: Numerical Weather Prediction

Lecture #3: Numerical Modelling of Atmospheres of the Planets Mars and Venus

Lecture #4: Climatology on Earth and Mars

Dr. W. Nordberg
Goddard Space Flight Center-NASA
Greenbelt, Maryland

Lectures #1-3: Satellite Contributions to Meteorology:

1. Need for close network of meteorological observations. Importance of the upper atmosphere observations. Sensors for observations from space.
2. Review of measurements obtained from balloon and rocket sounding, e.g., the vertical temperature profile of the atmosphere, the measurement of wind speeds and shears by Sodium vapor trails.
3. Contribution of weather satellites: Vanguard, Tiros, Nimbus series. Some technical aspects of satellite stabilization: spin and magnetic field stabilization. Horizon to horizon scanning from satellite: photographic and radiometric. Weather satellites in synchronons orbit; its advantages.
4. Radiometers: physical components, their modes of operation. Bolometers and photo-detectors: essential differences. General detector parameters: detectivity noise, equivalent temperature, time constant. Cryogenic methods.
5. Radiometric measurements from satellites: measurements in CO_2 and water vapor bands; determination of average water vapor content in the upper troposphere.

Professor Elmar R. Reiter
Department of Atmospheric Science
Colorado State University, Fort Collins, Colorado

Lecture #1: The Jet Stream:

Discovery of jet streams; physical principles of their origin. jet streams in geophysical model experiments; the importance of jet streams in the general circulation of the atmosphere.

Lectures #2, 3: Jet Streams and Weather:

Cyclones and anticyclones and their relationship to upper atmospheric circulation patterns; unusual weather patterns such as hurricanes, typhoons, etc.; observational systems aiding the meteorologists such as satellites, global balloon systems, etc.

Lecture #4: Jet Streams and Aviation:

The problem of turbulence in the free atmosphere.

SUGGESTED READING MATERIAL

Herbert Riehl: Introduction to the Atmosphere. McGraw-Hill, (1965).

Dr. F. E. Roach
Institute for Telecommunication Sciences and Aeronomy-ESSA
Boulder, Colorado

Lecture #1: The Green Airglow:

Introduction: The Light of the Night Sky

The Airglow (Nightglow) from "Space"

The Airglow from the Earth's surface

-- Increase twoard horizon. Van Rhyn formula

-- Definition of the "raleigh"

-- The energy level diagram of atomic oxygen

-- The human eye and visibility

The structure, movements and statistics of the green airglow

photochemical reactions in the upper atmosphere

SUGGESTED READING MATERIAL

J. W. Chamberlain: Physics of the Aurora and Airglow, Chapters 1, 2, 9

R. E. Roach: The Nightglow, in Advances in Electronics, Vol. 18.

Lecture #2: The "Red" Airglow and Aurora:

Airglow zones and geomagnetic control

The tropical airglow and ionospheric correlations

Photochemistry of the "F Region"

Corrugated structure of the F Region

The "Equatorial Anomaly"

Mid-latitude auroras - thermal excitation

The yellow and infrared airglow

The polar aurora

SUGGESTED READING MATERIAL

J. W. Chamberlain: Physics of the Aurora and Airglow, Chapters 9, 13, Academic Press, (1961)

F. E. Roach and J. R. Roach: Stable 6300A, Auroral Arcs in Mid-Latitudes, Planet and Space Sciences 11, 523, (1963)

D. Barbier, F. E. Roach and W. R. Steiger: Int. Research NBS, 66D, 145, (1962)

Dr. S. F. Singer
Institute of Atmospheric Science
University of Miami, Coral Gables, Florida

EARTH'S RADIATION BELTS

Historical Account

Two radiation belt zones

Composition and energy spectrum of belt particles

Theories of origin of the two belts

APPENDIX 6

PART 4

OCEANOGRAPHY AND MARINE SCIENCE

Dr. S. Broida
Institute of Marine Science
University of Miami, Miami, Florida

INTRODUCTION TO PHYSICAL OCEANOGRAPHY

Ocean Waves: surface, tidal and internal waves

Salinity: estimate of salinity, saline contraction

Isotherms, isopycnals, isobars, isohalines

Turbulent diffusion, Thermo-haline circulation

Geopotential, geopotential anamoly, potential temperature

SUGGESTED READING MATERIAL

Sverdrup, Johnson and Fleming: The Oceans, Prentice-Hall, (1942)

Henry Stommel: The Gulf Stream, University of California Press, (1958)

W. S. vonArx: Introduction to Physical Oceanography, Addison-Wesley, (1962)

J. Proudman: Dynamical Oceanography, John Wiley and Sons, (1953)

A. Defant: Physical Oceanography, Vols. 1 and 2, Pergamon Press, (1961)

<u>Journals:</u>

Deep Sea Research

Journal of Marine Research

Tellus

Journal of Geophysical Research

Limnology and Oceanography

Dr. K. P. Chopra
Institute of Atmospheric Science
University of Miami, Coral Gables, Florida

SATELLITE METEOROLOGY

How earth satellites can help study oceans. The oceanic parameters that need to be studied. Criteria and limitations for these studies. Limitations of instrumentation. Satellite meteorology and satellite oceanography -- comparisons and contrasts in missions and objectives.

Dr. Walter Drost-Hansen
Institute of Marine Science
University of Miami, Miami, Florida

Lecture #1: Liquid Structure

Lecture #2: Structure of Water:

Properties of water

The chemico-physical aspects

Electrolyte solutions

Review

Lecture #3: Structure of Ice:

Discussion

SUGGESTED READING MATERIAL

J. Frenkiel: Kinetic Theory of Fluids, Dover Publications, Inc., (1955)

J. A. Barker: "Lattice Theories of Liquids", in International Encyclopedia of Physical Chemistry and Chemical Physics, ed. by Guggenheim, Mayer and Tompkins.

S. Flugge, Ed.: Encyclopedia of Physics, Vol. 10, Springer Verlag, (1960)

J. L. Kavanan: Water and Solute-Water Interactions, Holden Day, Inc. (1964)

W. Drost-Hansen: Annals of New York Academy of Sciences, Conference Monograph #125, Art. 2, p. 471 (1965)

G. Nemethy and H. A. Scheraga: Journal of Chemical Physics, Vol. 36, p. 3382, (1962)

R. W. Gurney: Ionic Processes in Solutions, Dover Publications (1962)

R. A. Robinson and R. H. Stokes: Electrolyte Solutions, Butterworth Scientific Publications (1959)

Harved and Owen: Physical Chemistry of Electrolytic Solutions, Reinhold Publishing Co., (1963)

E. R. Pounder: The Physics of Ice, Pergamon Press, (1965)

W. D. Kingery, Ed.: Ice and Snow--Properties, Processes and Applications, M. I. T. Press, (1963)

Dr. Michael Garstang
Department of Meteorology
Florida State University, Tallahassee, Florida

Lecture #1: <u>Fundamentals of Energy Exchange Between the Ocean and Atmosphere:</u>

A. Large scale motions, constraints, geostrophic planetary motion, the Rossby Number;

B. Absorption of short wave radiation by the atmosphere, the surface of the earth, the atmosphere fuelled mainly from below;

C. Radiation balance of the earth-atmosphere system;

D. Energy exchange: the budget method, the bulk aerodynamic equations, eddy correlation techniques.

Lecture #2: <u>Planetary Distrubtion of Energy Flux</u>:

A. Global distributions of sensible and latent heat exchange;

B Diurnal variations in heat flux;

C. Synoptic-scale variations in heat flux;

D. The role of air-sea interaction in the synoptic-scale systems;

E. The role of air-sea interaction in the general circulation of the tropics.

SUGGESTED READING MATERIAL

M. N. Hill; The Sea, Gen. Ed. Interscience 1962, article by Malkus, pp. 92-103; 106-148, articles by Deacon & Webb, pp. 43-60; 66-67.

H. U. Roll: Physics of the Marine Atmosphere, Chapters 4 & 5, Academic Press, (1965)

T. F. Malone, Ed.: Compendium of Meteorology, American Meteorological Society, Boston, (1951). Article on Large Scale Aspects of Energy Transformation over the Oceans, p. 1057-1070.

Dr. Robert J. Hurley
Institute of Marine Science
University of Miami, Miami, Florida

Lecture #1: <u>The Floors of the Oceans:</u>

A. Introduction - why study oceans?

B. The differences between the ocean basins and continents

   1. height

   2. thickness

   3. rock types

   4. types of deformation

C. How to study?

   1. problems of the "wet stuff"

   2. evading problems and limitations imposed

   3. conclusions from subtle clues - a detective story

D. Status of knowledge - facts

E. Status of understanding and interpretation

   1. problems (examples)

      a. age

      b. island arcs - trenches

      c. midocean ridges

      d. in fact, why are there continents?

F. Abyssal Hills - a detective story - unended

   1. what are they

   2. what is known

   3. how could they be formed

   4. what tests or experiments

   5. progress to date

   6. the future

SUGGESTED READING MATERIAL

F. P. Shepard: The Earth Beneath the Sea, Johns Hopkins Press, (1959)

H. W. Menard: Marine Geology of the Pacific, McGraw-Hill, (1964)

Dr. J. Isaacs
Scripps Institute of Oceanography
LaJolla, California

Lectures #1-3: Air-Sea Interaction

Dr. F. F. Koczy
Institute of Marine Science
University of Miami, Miami, Florida

Lecture #1: Nuclear Oceanography:

Radioactive decay, isotope ratios in nature. Processes affecting isotope ratios as fractionation by diffusion, evaporation, freezing, precipitation, metabolic processes. Uses in oceanography: paleo-temperature, tagging of water masses, rates of mixing, overturn of water.

SUGGESTED READING MATERIAL

Israel and Krebs: Nuclear Radiation Geophysics, Springer, (1962)

Faul, Ed.: Nuclear Geology, John Wiley & Sons, (1954)

Radioactive Tracers in Oceanography: Natural Radionuclides in the Ocean. International Union of Geodesy and Geophysics, Monograph No. 20. Papers presented at a Symposium of the Tenth Pacific Science Congress, Univ. of Hawaii, Honolulu, Hawaii, August-September, (1961)

Lecture #2: History of Ocean Water:

Ocean water's Composition. Question of origin, oceanic elements. Primary atmosphere, geochemical balance of elements between rocks, atmosphere and ocean, production of oxygen, condensation of water, solution of gases, reaction with rocks, volatiles from the earth, weathering, changes by metabolic processes, quantitative considerations.

SUGGESTED READING MATERIAL

G. Sillen: Physical chemistry of oceanwater. Oceanography, Ed. Mary Sears, AAAS, (1961)

Wedepohl: Einige Überlegungen Zur Geschichte des Meereswassers. in Üterscheidungsmoglichkeiten mariner und nicht-mariner Sedimente. Krefeld 1963, Fortschritte der Geologie von Rheinland and Westfalen.

Symposium on the evolution of the earth atmosphere. Proceedings NAS Vol. 53, No. 4, p. 1169-1226, (1965)

Riley, Ed.: Chemical Oceanography, Vol. I and II, (1965, 1966)

Lt. Cmdr. Lawniczak
Fleet Numerical Weather Facility
Monterey, California

NUMERICAL OCEANOGRAPHY

SUGGESTED READING MATERIAL

Numerical Methods for Synoptic Computation of Oceanic Fronts and Water Type Boundaries and their Significance in Applied Oceanography, Fleet Numerical Weather Facility, Technical Note No. 20, June 1966.

Oceanographic Analyses and Forecasts for Fleet Support (Services and Codes), Fleet Numerical Weather Facility, Technical Memo No. 11-1, March 1966.

Dr. Myrberg
Institute of Marine Science
University of Miami, Miami, Florida

BEHAVIOR AND SENSORY PHYSIOLOGY OF MARINE ORGANISMS

Lecture #1: Introduction:

A. The environment and the problem of adaptation

B. How does the organism gain information about its environment?

C. The use of such information in bringing about the orderly nature of behavior.

Lecture #2: Physiological and Behavioral Studies:

A. Selected sensory physiological studies

1. invertebrates

2. vertebrates

B. Selected behavioral studies

1. invertebrates

2. vertebrates

Appendix 7

FINAL EXAMINATION

FINAL EXAMINATION

UNIVERSITY OF MIAMI

SECOND ANNUAL SUMMER SCHOOL ON FUNDAMENTAL CONCEPTS IN ENVIRONMENTAL AND PLANETARY SCIENCES

PART A

I. Select any five (5) of the following statements and check if each of these is true or false:

	TRUE	FALSE
(1) A Markov process is a special case of Poisson processes.	____	____
(2) TiN has been found as a mineral in meteorites.	____	____
(3) Chondrules that contain pyroxene will not contain olivine.	____	____
(4) The higher the Ni- content of octahedrites the coarser their Widmanstatten lamellae.	____	____
(5) The ages of formation of iron meteorites and stony meteorites seem to be significantly different.	____	____
(6) Stishovite is easily transformed into quartz glass by heat treatment at 300^{o} C.	____	____
(7) Lechatelierite is the low-temperature modification of coesite.	____	____

II. Check such parts of any five of the following statements as are appropriate, correct and factual:

1. Most leading meteorite scientists agree that the meteorites derive:

   (a) from the moon.
   (b) from a collision between two asteroids.
   (c) partly from the moon, partly from the planet Mars.
   (d) from sources other than those enumerated above.

2. Rapidly rising electrical conductivity of the earth's mantle at about 700 km depth is due to:

   (a) semi-conduction in the ferromagnesium silicates,
   (b) a small percentage of iron in a matrix of insulating silicates.
   (c) a transformation under pressure of silicate to a metallic phase.

3. The differences between the moments of inertia about polar and equatorial axes of the earth, Moon and Mars are calculable from:

   (a) the periods of rotation of their satellites, both natural and artificial.
   (b) their periods of rotation about their primaries.
   (c) the periods of precession of their axes of rotation in space.

4. Paleomagnetic and palocondriatic evidence demonstrates that the continents have drifted thousands of kilometers:

   (a) in the pre-Cambrian times only and not since.
   (b) since late Palaeozoic era.
   (c) only in the Quaternary era.

5. The geomagnetic daily variation measured at observatories at the Earth's surface arise from the electric currents:

   (a) in the earth's mantle.
   (b) in the ionosphere.
   (c) in the earth's mantle and in the ionosphere.

6. The magnetic fields of stars as determined so far are of the order of:

   (a) a few oersteds.
   (b) thousands of oersteds.
   (c) millions of oersteds.

7. Magnetic fields are known to exist on:

   (a) Jupiter and Saturn, and not on Mars, the Moon and Venus.
   (b) Jupiter and Venus, and not on Saturn, Mars and the Moon.
   (c) Mars and the Moon and not on Saturn, Venus and Jupiter.

8. Tensional features in the earth's crust are:

   (a) oceanic ridges and continental rift valleys.
   (b) oceanic ridges and mountain building belts.
   (c) oceanic trenches and mountain building belts.

PART B

III. Check correct portions of any five (5) of the following statements:

1. A 420 Hz wave is continuously transmitted under-water from point A to point B. During a one-hour interval beginning at time T_0, the phase of the received wave, referenced to its phase at T_0, advanced 360^o. Assuming a mean sound speed of 1500 meters per second, the change of path length corresponding to the phase advance was:

   - ☐ an increase of 18 m
   - ☐ an increase of 3.6 m
   - ☐ a decrease of 18 m
   - ☐ a decrease of 3.6 m

2. The existence of the western boundary currents in each of the major ocean basins is explained by a simple mathematical model combining the following physical processes:

☐ zonal wind distribution
☐ geostrophy
☐ variation of temperature with depth
☐ variation of coriolis force with latitude salinity

3. The ratios O^{18}/O^{16} in carbonates

☐ increases
☐ decreases

when the sea-water temperature at which they are formed is increased.

4. The rate of over-turn of ocean water is estimated by the study of distribution of

☐ radium^{226}
☐ iodine^{129}
☐ carbon^{14}
☐ tritium
☐ uranium^{238}

5. The p-H value of sea-water is 8.1 ± 0.2 and determined by the

☐ carbonate system in sea-water
☐ CO_2 pressure in atmosphere
☐ Ion-exchange reactions between minerals and ions in solution
☐ Ionic concentration of sea-water.

6. During the last 3.10^9 years, the volume of ocean water has

☐ remained constant
☐ increased
☐ decreased

7. The minimum depth (below sea-level) to which you would have to drill to find rocks of identical types beneath oceans and continents is at least

☐ 1 km
☐ 5 km
☐ 10 km
☐ 40 km
☐ 400 km

8. It is said that more is known of the surface of the Moon than the floor of the oceans. The reason is

☐ It is cheaper to investigate the surface of the Moon.
☐ The potential economic value of the Moon is greater.
☐ The opacity of sea-water makes studying the sea floor more difficult.
☐ There is no challenge in a study of the ocean basins.

IV. Check any two of the following statements if each is true or false:

	TRUE	FALSE
1. The atmosphere absorbs about 20% of the incoming solar radiation, from this we conclude that the atmosphere is fuelled mainly from below.	____	____
2. The ratio of sensible to latent heat, known as the Bowen ratio, equals about 0.5 over the open tropical oceans.	____	____
3. Marine fog invariably results from the adiabatic expansion of air saturated with water vapor.	____	____

V. Circle one answer closest to truth in any three (3) of the following questions. Fill in blanks if appropriate and necessary, or match numbers.

1. The ocean circulation appears to be coupled kinetically with the atmospheric circulation mainly through drag forces -

   ☐ Yes, but there are many important interactions of other natures.

   ☐ No, it is coupled by pressure gradients.

   ☐ That (1) is what Professor Isaacs said, but I am not convinced that this is necessarily so. It seems to me that ______________ is also very important for the following reasons:

2. The free surface wave velocity in the deep sea is much less than the velocity of movement of atmospheric weather features - hence, coupling between such processes as hurricanes and surges takes place mainly over the shelves -

   ☐ Forsooth!
   ☐ Negative
   ☐ The statement is equivocal, partly wrong and partly right.

3. The most consequential velocity affecting the circulation of the sea is the earth's angular velocity -

   ☐ I am more troubled by what the composer of the question had in mind than I am with the proper answer. The question would be clearly answerable as true if the composer had said "a very consequential" - as it stands I have to guess at what is expected (like I have been doing through much of school.

   ☐ Clearly true.

   ☐ Clearly false.

4. Radioactive fission products introduced into the ocean environment appear to interact through a chemical and biological milieu that is so different from that on land as to greatly influence the importance of the various radioisotopes -

- ☐ The sentence is too long to be very intelligible, but I believe it to be true.
- ☐ Professor Isaacs said this, but did not give me a sufficient background for me to be convinced that he was right.
- ☐ I think the statement is wrong, especially the use of the word "milieu" which is a French word meaning hat.

5. Much of solar radiation is involved in evaporation from the ocean surface -

- ☐ Yes, indeed.
- ☐ No, indeed.
- ☐ This is another of those stupidly stated questions that I have been puzzling over all my life. The solar energy obviously is almost all radiated to space and only an idiot would think that "much" of it was involved in evaporation of the world's ocean. However, I suppose that the guy who wrote the question didn't think about that at all and so I'll answer the statement as true, but with some irritation.

PART C

Check correct answers to any ten (10) of the following questions:

1. Hurricane is a tropical storm with speeds in excess of

   - ☐ 50 m.p.h.
   - ☐ 70 m.p.h.
   - ☐ 90 m.p.h.
   - ☐ 100 m.p.h.

2. Tritium is a tracer than can be used to study

   - ☐ the atmospheric greenhouse effect
   - ☐ the air-sea exchange of water

3. The critical size of a water droplet growing in supersaturated atmosphere depends on

   - ☐ the relative humidity
   - ☐ the crystal structure of the nuclei it contains
   - ☐ the mass of the hygroscopic material in it.

4. The 9.6 μ band of ozone is weak. Nevertheless, this band is important, because

   - ☐ there is plenty of ozone in the atmosphere
   - ☐ it occurs in a wavelength range where CO_2 and H_2O are not active
   - ☐ it reinforces a water vapor band of similar wavelength.

5. If the lapse rate in the free atmosphere is $5^{o}C/km$, a parcel of dry air displaced adiabatically upwards will

   ☐ become cooler than the surroundings, and will therefore return to its starting level.

   ☐ Become warmer than its surroundings, and will therefore continue to displace itself further.

   ☐ Will be in adiabatic equilibrium with its environment and will remain in the displaced position.

6. The lapse rate of an atmosphere containing water and in adiabatic equilibrium is:

   ☐ higher than the dry adiabatic lapse rate because the latent heat of melting is extracted from the atmosphere to convert ice (hail stones) into inquid water.

   ☐ lower than the dry adiabatic lapse rate because the latent heat of condensation of water vapor is made available as sensible heat of the atmosphere.

7. The molecular or atomic diffusion in a planetary atmosphere is due to

   ☐ gravity
   ☐ variation of pressure with height
   ☐ variation of temperature with height

8. Photo-dissociation of a nitrogen molecule into its two nitrogen atoms results in the transport of the latter in the vertically

   ☐ upward direction
   ☐ downward direction

9. The scale height is determined by

   ☐ the mass and size of a star or a planet
   ☐ the local values of molecular mass and temperature of
   ☐ the atmospheric gas

10. The drifts of positively and negatively charged particles due to the influence of gravity are

    ☐ in the same sense
    ☐ in the opposite sense

11. A charged particle colliding with a receding magnetic barrier

    ☐ gains kinetic energy
    ☐ loses kinetic energy

12. The equation $\Delta S = (\Delta Z/V)\ (\vec{W} - \vec{A})$ describes the horizontal displacement of particles of fall speed V while they are in a layer of thickness Z where the horizontal speed is $\vec{W}$ and $\vec{a}$ is a constant. Given that $\vec{W}$ is a linear function of the height Z and is always in one plane, the resulting trail pattern is:

   - ☐ straight
   - ☐ horizontal and flat
   - ☐ parabolic

13. Atmospheric green-house effect is a phenomenon in which:

   - ☐ light from blue stars is doppler-shifted to appear green

   - ☐ Starlight scattered by Earth and its atmosphere would appear green as viewed by an extra-terrestrial visitor.

   - ☐ The long wave radiation emitted by earth is contained in the lower layers of the atmosphere due to the action of water vapor and clouds in the atmosphere.

14. The ozone-peak is due to

   - ☐ the peak concentration of oxygen molecules at this level

   - ☐ the peak intensity of radiation needed for photo-chemical processes involved in the formation of ozone

   - ☐ the optimum cross-section of the necessary photochemical reactions due to the vertical variations of the concentration of O_2 and the intensity of the needed solar ultraviolet radiation.

15. The wind speed at ground level is

   - ☐ larger than that at upper layers because the wind from top layers continuously transfers its kinetic energy to lower layers.

   - ☐ smaller than that at upper layers because of the action of friction at ground and viscosity of air.

16. The atmospheric vortex patterns in the vicinity of islands are observed at low inversion conditions because

   - ☐ the atmosphere is stable
   - ☐ the atmosphere is unstable.

PART D

Check correct portions of any ten (10) of the following statements:

1. Sun radiates as

   ☐ a perfect black body at a temperature of 5700° K.
   ☐ a black body in select parts of the spectrum.

2. Solar observations made with an unfiltered telescope transmitting visible or "white light" radiation (wavelengths between 3000 and 7500 Angstroms, approximately) do not, except in rare instances, reveal any solar flares which are in progress at the time. Why is this true?

   ☐ white light radiation from the sun originates at the photospheric level whereas most flares occur in the chromosphere.

   ☐ The intensities of flares relative to the photospheric white light background are usually too low to allow them to be discerned.

   ☐ Flares do not normally radiate at visible wavelengths.

   ☐ None of the above choices are relevant since the statement is, in fact, a lie.

3. The temperature profile of the solar atmosphere

   ☐ has a minimum at the top of the photosphere and rises most rapidly in the lower corona.

   ☐ has a minimum at the top of the chromosphere and rises most rapidly in the corona.

   ☐ increases monotonically with increasing distance above the base of the photosphere.

   ☐ Does not exhibit a marked variation with height.

4. The parallax of a star is the shift in its direction as viewed from two separate points, and is used to determine its distance. The separation of the viewing points is the result of:

   ☐ the earth's rotation around its polar axis
   ☐ the motion of the earth and moon around their center of mass
   ☐ the revolution of the earth around the sun.

5. Kepler's third law (harmonic law) states that the period of revolution about the sun of a planet is specifically related to:

   ☐ the mass of the planet
   ☐ the eccentricity of the planet's orbit
   ☐ the average distance between the sun and the planet

6. The Ranger and Surveyor programs have provided us with much new information concerning the nature of the lunar Maria. This information makes it possible to conclude

   ☐ there is no dust layer on the lunar surface

   ☐ the lava flow theory of the origin of the Maria is the only satisfactory theory.

   ☐ the surface consists of vesicular rock

   ☐ the presence of only shallow craters indicates a granular subsurface.

7. Assume that all the cosmic ray protons in our galaxy have the following over-simplified spectrum:

   $\frac{dn}{de} = O \qquad E < 10^9$ cv

   $\frac{dn}{de} = K\ E^{-2.5} \qquad 10^9$ cv. $< E < \infty$

   What is the mean energy of a cosmic ray proton in the galaxy?

   10^8 cv _____ 3×10^9 cv _____   infinite _____

8. Those factors which lead to difficulty in determining the surface temperature of the moon as deduced from radiometric measurements in the infrared made from the earth's surface are:

   ☐ Imperfect transparency of the earth's atmosphere, i. e. absorption and re-emission.

   ☐ Non blackness of lunar surface, i. e. emissivity < 1.

   ☐ (On daylight side) reflection of solar energy from lunar surface.

9. Differences between stellar spectre of types B, A, F, G, K, are primarily due to differences in:

   ☐ The distances of the stars
   ☐ The chemical compositions of the stars' surfaces
   ☐ The sizes of the stars
   ☐ The temperatures of the stars' surfaces
   ☐ The telescopes used to observe the stars.

10. The theory that nuclear energy accounts for the luminosity of the stars implies that the chemical composition of stars and galaxies is changing with time

   ☐ True
   ☐ False
   ☐ True in the case of all but the bright blue stars.

11. Inside a star the temperature

- ☐ Increases with depth below the surface
- ☐ Increases for part of the way, then decreases
- ☐ Is the same as the surface temperature
- ☐ Decreases toward the center

12. A star on the "main sequence" of the H-R diagram remains about the same for t years. This life-time t, is

- ☐ the same for all stars: about 5 billion years
- ☐ longer for large, bright blue stars; much shorter for small red stars
- ☐ sometimes long, sometimes brief; unpredictable
- ☐ millions of years for large, bright blue stars, and billions of years for small, faint red stars.

13. The redshift of a galaxy is measured by

- ☐ the redder color viewed in a telescope
- ☐ abnormal positions of lines in the spectrum
- ☐ smaller image than expected on a photostat
- ☐ it cannot be measured

14. The statement "Redshifts of galaxies are very nearly proportional to their distances".

_____ True _____False

PART E

Write a short essay (about 300 to 400 words) on any topic or sub-topic you have learned most in this course.

APPENDIX 8

CERTIFICATE OF SUCCESSFUL PARTICIPATION

The School of Environmental and Planetary Sciences of the University of Miami

This is to certify that

has successfully completed the second annual intensive course on Fundamental Concepts of Environmental and Planetary Sciences at the University of Miami in Coral Gables, Florida Presented under the joint sponsorship of the National Aeronautics and Space Administration, and the Bureau of Cultural Affairs of the United States Department of State

A. H. Gropp *Vice President for Academic Affairs,* *Dean of Faculties*	*K. P. Chopra* *Associate Director*

APPENDIX 9

FIELD TRIP TO CAPE KENNEDY

KENNEDY SPACE CENTER TOUR

SUMMER COURSE IN ENVIRONMENTAL AND PLANETARY SCIENCES

July 21, 1966

5:45 A.M.	Coffee and Rolls, Patio of Union Building
6:00 A.M.	Bus Departs for Kennedy Space Center. Bus will load at circle driveway between Union Building and Richter Library.
10:30	Arrive at Gate 3, Kennedy Space Center. This is the main entrance to the Merritt Island Complex and is on Highway No. 1 just south of Titusville.
10:45-11:00	Welcome Paul O. Siebeneichen, Chief, Education and Community Services Branch, Kennedy Space Center
11:00-11:45	NASA Operations at Kennedy Space Center Film, "Spacequest 1965" U. Wright Kerns, Education and Community Services Branch, Kennedy Space Center
11:45-12:15	Discussion
12:15-1:00	Lunch Central Cafeteria Kennedy Space Center
1:00-2:00	Report on Surveyor H. N. Levy, Jr., Manager, Jet Propulsion Laboratory at Cape Kennedy
2:00-3:30	Tour, Cape Kennedy Air Force Station John P. Nelson, Education and Community Services Branch, Kennedy Space Center
4:00 P.M.	Check in at Ramada Inn Motel, Cocoa Beach, Florida 783-9441
8:00 P.M.	NASA FILMS. Location to be announced.

KENNEDY SPACE CENTER TOUR

July 22, 1966

8:00 A.M.	Bus departs from Ramada Inn for Kennedy Space Center.
8:30-9:15	Tour, Manned Spacecraft Operations Building Sammuel T. Beddingfield, Spacecraft Operations, Kennedy Space Center
9:15-10:15	Tour, Central Instrumentation Facility Joe R. Smith, Information Systems, Kennedy Space Center
10:15-11:15	Tour, Complex 39 John P. Nelson, Education and Community Services Branch, Kennedy Space Center
12:00	Departure from Kennedy Space Center
12:30 P.M.	Swim at Cocoa Beach
3:30	Bus departs on return trip.
8:00	Arrive at University of Miami Campus.

APPENDIX 10

STUDENT EVALUATION OF THE PROGRAM

(Questionnaire)

SCHOOL OF ENVIRONMENTAL AND PLANETARY SCIENCES

SUMMER INSTITUTE QUESTIONNAIRE

This questionnaire is designed to help us in the evaluation of the Summer Course on Fundamental Concepts of Environmental and Planetary Sciences. Your comments will be used in modifying the Course scheduled for the summer of 1967 and will be of great help, therefore, to future generations of summer students.

(1) COURSE CONTENT

Do you think that the subjects covered were in proper balance (a) from the point of view of topics (astrophysics, atmospheric physics and oceanography, geophysics and geology, colloquium lectures, etc.); (b) in the distribution of theoretical subject matter, and experimental subject matter. Please discuss below.

(2) MANNER OF PRESENTATION

Please comment on the lecturers themselves and on their way of handling their subject matter, whether too much outline material or too much detail, or whether just about right. Do you find the overall view more useful or do you prefer to delve deeply into a smaller topic? What characteristic of the lecturers did you enjoy most and what characteristic of the lecturers did you enjoy least?

(3) INSTRUCTIONAL AIDS

Please comment on the value of the course outlines, their timeliness, on the method of visual presentation, and on the value of the films.

(4) TRIPS AND VISITS

Please tell which of the trips and visits were most educational and enjoyable, which should be expanded or introduced, and which could be deleted.

(5) GENERAL IMPRESSIONS

Do you believe that as far as you are concerned, the Course has fulfilled its major purpose; namely, to stimulate an interest in pursuing a graduate and research career in the environmental sciences?

If you do not plan to pursue such a career, please indicate whether the Course has been worthwhile in broadening your outlook on science as a whole by receiving this training in the environmental and planetary sciences.

(6) Please comment on facilities in general in regard to housing accomodations, food service (was it helpful to purchase meal tickets, or did you prefer to eat off campus?). Did you enjoy your time spent as a student and as a visitor in Miami?

Signature ______________________________